Vanvitelli's (*i. e.* one of them), as to exhibit all its merits, notwithstanding that it exhibits qualities precisely the reverse. Yet, surely littleness and magnitude are very different in effect; or shall we say, that if he be similarly shaped and proportioned, a dwarf can give us a very satisfactory idea of a giant? Those who hold such doctrine, ought to show their consistency by taking a sixpence as a very satisfactory representative of, and equivalent to, a shilling. Hardly can I bring myself to believe that Mr. Blore had any idea of palming upon us a Tom Thumb Caserta, because, leaving plagiarism out of the question—and in architecture plagiarism has ceased to be any demerit or disgrace—he must have been perfectly aware that he must fall so greatly short of Vanvitelli's standard, that likeness in other respects would, if detected, only produce ridicule. No, what kind of likeness there is between the two designs is merely a coincidence, and for Mr. Blore rather an unfortunate one. Had it been intentional and "with malice prepense,"—had Mr. Blore really fancied that he could reproduce Caserta, he would no doubt have avowed the imitation, have made it a merit, and have crushed criticism in the bud, by proclaiming that he was about to give Buckingham Palace a façade "after" that of the noblest royal residence in Europe.*—In such cases, be it observed, the *after* generally means a long way *behind* the prototype; and the following comparison of the respective measurements of some of the parts of the two buildings will show that Vanvitelli's afforded no precedent for the *mesquinerie* of Mr. Blore's.

	ft.	in.		ft.	in.
Caserta.					
Basement or ground floor, mezzanine,	47	4	high		
Gateways through ditto	16	6	wide;	36	2 high
Principal floor windows	6	10	wide;	14	0 high
Columns	49	0	high		
Buckingham Palace.					
Basement	26	0	high		
Gateways: centre one, ...	13	6	wide;	21	0 high
lesser ones, ...	10	0	wide;	18	0 high
Principal floor windows	4	6	wide;	11	0 high
Pilasters	34	0	high		

After all, had its elevation been ever so much better, Mr. Blore's building would still have been open to some of the strongest objections brought against it now, viz., that it seems to encroach upon the Park in such a very awkward manner, as to appear a more lumpish mass than it otherwise might do, and that blocking up all the rest of that side of the Palace, so far from improving the main edifice, it has frustrated that opportunity for improvement which previously existed, and which, since alteration to such extent was determined upon, ought to have been made the most of. As a range of building the new façade is scarcely more effective than the neighbouring barracks in the Birdcage Walk, to which it may in fact be likened quite as correctly as to Caserta; nor would that comparison be, though less flattering, quite so injurious as the other, inasmuch as it must then be admitted that, instead of there being any falling off, the model had been refined upon.

One defect in regard to position, now rendered very prominent by the building being brought so much forwarder into the Park, is that the Palace is not in the axis of the Park itself, but only of the Mall; whereas, were Mr. Blore's structure planted at the other extremity of the enclosure, on the site of the Horse Guards, it would there show infinitely better in every respect, and, with some slight corrections, might pass for a handsome piece of architecture. As it is, it is altogether out of place, out of character, and the reverse of satisfactory in effect; nor can I agree with Mr. Sharp that were Mr. Blore "to give the Palace a staircase resembling that at Caserta, the world would forgive him all the faults of his front;" because while those faults would be just as evident as ever, the public would have no opportunity of admiring the staircase. Besides which, it would require the architect to be the Bottle-Conjuror to get such a staircase into Buckingham Palace; and even could it be effected, it would reduce all the rest of the interior to utter insignificance.—One other remark, and I have done: for what will perhaps be considered lengthiness and loquacity I have no precedent in what Mr. Sharp's companion, Woods, says in his "Letters" of Caserta, for he dismisses it with little more than a bare mention of it,—with a degree of chilling indifference that does not say much for him either as an architect or a critic.

* Quatremere de Quincy says of Caserta: "Une plus grande conception de palais n'existe point en Europe."

ON THE LAP AND LEAD OF THE SLIDE VALVE.

(Concluded from page 17.)

The Lead and Lap.

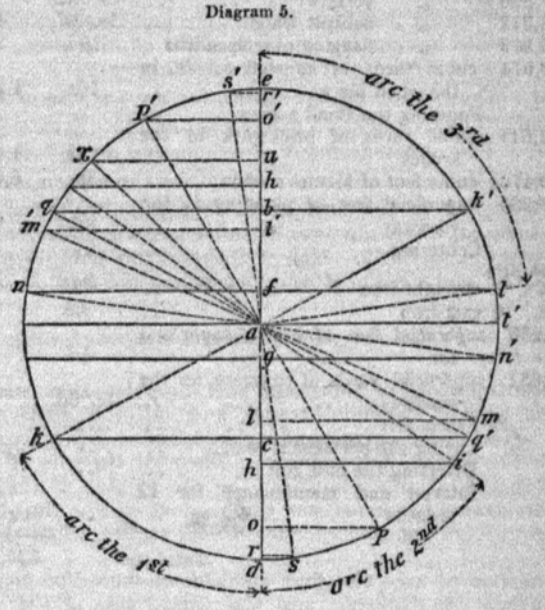
Having separately investigated the two cases of a slide having Lead without Lap, and Lap without Lead, we now proceed to consider the effect of both in combination, together with that of lap on the exhaustion side.

Demonstration.

Case 4.—When a Slide has Lap on both the Steam and Exhaustion sides, together with Lead.

Let $a\,b$, and $a\,c$, diagram 5, represent the double lap on the steam side; $a\,f$, and $a\,g$, the same on the exhaustion side; $b\,e$, and $c\,d$,

Diagram 5.



the steam ports; and the line $e\,d$ both the travel of the slide and stroke of the piston. Then, supposing $c\,h$ to represent the lead of the slide, $a\,i$ will be the position of the eccentric when that of the crank is $a\,e$; the slide occupying the position shown in fig. 10, and the piston being at the top of its downward stroke.

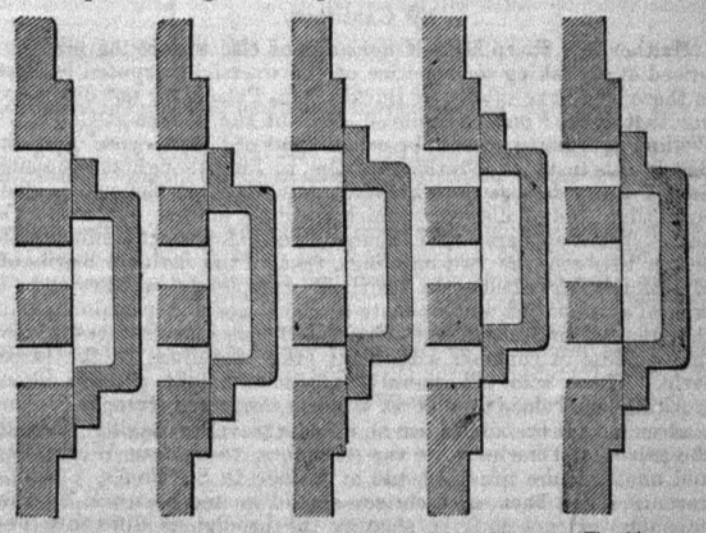


Fig. 10. Fig. 11. Fig. 12. Fig. 13. Fig. 14.

When the eccentric reaches the point k, the port $e\,d$ will be fully closed (as shown in fig. 11), and the piston will have descended to l, the arc $e\,m$ being equal to the arc $i\,k$. Again,—when the eccentric arrives at n, the slide being then brought into the position fig. 12, exhaustion commences from above the piston, which has descended to o; the arc $e\,m\,p$ being equal to the arc $i\,k\,n$. When

the eccentric arrives at q, the port $b\,e$ begins to open for the admission of steam beneath the piston (see fig. 13), which has then descended to r; the arc $e\,m\,s$ being equal to the arc $i\,k\,q$. When the eccentric has reached the point i', opposite to i, the port $b\,e$ will be open to the extent of the lead $b\,h'$, equal to $e\,h$, and the piston will have completed its descent.

Steam continues to enter the port $b\,e$ during the ascent of the piston, until the eccentric reaches the point k', when the port $b\,e$ will be reclosed (fig. 13), the direction of the slide's motion being downward, and the piston having ascended to l'. Exhaustion ceases from above the piston when the eccentric reaches the point t, the piston being then at u, and the slide again in the position fig. 12. When the eccentric reaches the point n', opposite to n, exhaustion commences below the piston, the slide being then in the position fig. 14, and the piston at o'. Finally,—when the eccentric reaches the point q', and the crank the point s', opposite to s, steam begins to enter the port $c\,d$ for the return stroke, at the commencement of which the port $c\,d$ will be open to the extent of the lead $c\,h$; the crank and eccentric occupying their original positions, $a\,e$ and $a\,i$.

It is here shown that four distinct circumstances result from the use of a slide having lap on both sides of the port, with lead, during a single stroke of the piston. These are—

First: The cutting off the steam, for the purpose of expansion.

Second: The cessation of exhaustion on the exhaustion side.

Third: The commencement of exhaustion on the steam side.

Fourth: The re-admission of steam for the return stroke.

With regard to the first of these results, we found the steam port $c\,d$ closed, when the crank and eccentric had described the equal arcs $e\,m$, and $i\,d\,k$. Now, $c\,d$, the steam port, is the versed sine of $d\,k$; and $h\,d$, the steam port *minus the lead*, is the versed sine of $i\,d$. Hence,

RULE V.—*To find the point of the stroke at which steam will be cut off:—*

Divide the width of the steam port, and also that width minus the lead, by half the slide's travel, and call the quotients versed sines. Find their corresponding arcs, and call them arc the first, and arc the second, respectively. Then, if the sum of those arcs be less than 90 degrees, multiply the versed sine of their sum by half the stroke, in inches, and the product will be the distance of the piston from the *commencement* of its stroke, when the steam is cut off.

If the sum of arcs the first and second exceed 90 degrees, subtract it from 180 degrees; and the versed sine of the difference, multiplied by half the stroke, equals the distance of the piston from the *end* of its stroke, when the steam is cut off.

Example 8.—The stroke of a piston is 60 inches; the width of steam port 3 inches; lap on the steam side $2\frac{1}{2}$ inches; lap on the exhaust side $\frac{1}{8}$th inch; and lead $\frac{1}{4}$ inch: required the point of the stroke at which steam will be cut off.

Here $\dfrac{3}{3+2{\cdot}5} = {\cdot}5454 =$ versed sine of 62° 58′ (arc the first);

and $\dfrac{3-{\cdot}5}{3+2{\cdot}5} = {\cdot}4545 =$ versed sine of 56° 57′ (arc the second).

Then $62° 58' + 56° 57' = 119° 55'$; and $180° - 119° 55' = 60° 5' =$ arc of versed sine, ·5012. $\cdot5012 \times 30 = 15{\cdot}036$ inches = distance of the piston from the *end* of its stroke when the steam is cut off.

Exhaustion was shown to cease, during the ascent of the piston, when the eccentric had reached the point t, and the crank the point x; the crank having described the arc $d\,k\,x$, equal to $i'\,e\,t$ described by the eccentric.

Now $i'\,e$ is equal to *arc the second* (Rule V.); and $e\,t$ is equal to 90 degrees minus $t\,t'$, or the arc of versed sine $e\,f$; and $e\,f$ is half the slide's travel minus the lap on the exhaust side. Hence,

To find the point of the stroke at which exhaustion ceases:—

Divide half the slide's travel, minus the exhaustion lap, by half the travel, call the quotient versed sine, and add its corresponding arc, calling it arc the third, to arc the second. The versed sine of the difference between their sum and 180 degrees, multiplied by half the stroke, equals the distance of the piston from the end of its stroke when exhaustion ceases.

Example 9.—The several proportions being as in the preceding example.

Here $3 + 2{\cdot}5 = 5{\cdot}5 =$ half the slide's travel;

and $\dfrac{5{\cdot}5 - {\cdot}125}{5{\cdot}5} = {\cdot}9772 =$ versed sine of arc 88° 42′ = (arc the third).

Then $88° 42' + 56° 57'$ (arc the second) $= 145° 39'$; and $180° - 145° 39' = 34° 21' =$ arc of versed sine, ·1743. $\cdot1743 \times 30 = 5{\cdot}229$ inches = the distance of the piston from the end of its stroke when exhaustion ceases.

Exhaustion was shown to commence from above the piston when the crank and eccentric had described the equal arcs $e\,k'\,p$, and $i\,d\,n$.

Now $i\,d\,n$ is equal to 180 degrees minus $n\,i'$; $n\,i'$ is equal to $n'\,i$; and $n'\,d$ is equal to arc the third. Hence,

To find the distance of the piston from the end of its stroke when exhaustion commences:—

Subtract arc the second from arc the third, and multiply the versed sine of their difference by half the stroke. The product will be the distance required.

Example 10.—The proportions being as in the two preceding examples.

Here $88° 42' - 56° 57' = 31° 45' =$ arc of versed sine, ·1496; and $\cdot1496 \times 30 = 4{\cdot}488$ inches, the distance required.

Steam was found to be re-admitted, for the return stroke, when the piston had reached the point r in its descent, the crank and eccentric having described the equal arcs $e\,k'\,s$, and $i\,d\,q$.

Now, $i\,d\,q$ is equal to 180 degrees minus $q\,i'$; i' being diametrically opposed to i. And $q\,i'$ is equal to $i\,q'$, the difference between arcs the first and second. Hence,

To find the distance of the piston from the end of its stroke when steam is re-admitted for the return stroke:—

Multiply the versed sine of the difference between arcs the first and second by half the stroke, and the product will be the distance required.

Example 11.—The proportions being as before.

Here $62° 58' - 56° 57' = 6° 1' =$ arc of versed sine ·0055.

Then $\cdot0055 \times 30 = {\cdot}165$ inches = the distance required.

RULE VI.—*To find the proportions of the steam lap and lead; the points of the stroke where steam is cut off, and re-admitted for the return stroke, being known:—*

When the steam is cut off before half-stroke, divide the portion of the stroke performed by the piston, by half the stroke, and call the quotient versed sine. Likewise, divide the distance of the piston from the end of its stroke when steam is re-admitted for the return stroke, by half the stroke, and call that quotient versed sine. Find their respective arcs, and also the versed sines of half their sum and half their difference. The width of the steam port in inches, divided by the versed sine of half their sum, equals half the travel of the slide; and half the travel, minus the width of port, equals the lap. The difference of the two versed sines last found, multiplied by half the travel of the slide, equals the lead.

When the steam is to be cut off after half-stroke, divide the distance of the piston from the end of its stroke by half the stroke; call the quotient versed sine, and subtract its corresponding arc from 180 degrees. Divide the distance the piston has to move when the steam is admitted for the return stroke, by half the stroke; call the quotient versed sine, and find its corresponding arc, Then proceed with the two arcs thus found, as in the former case.

Example 12.—The stroke of a piston is 60 inches; the width of steam port 3 inches; distance of the piston from the end of its stroke when steam is cut off 15·036 inches; and when steam is admitted for the return stroke ·165 inches: required the lap and lead.

Here $15{\cdot}036 \div 30 = {\cdot}5012 =$ versed sine of arc 60° 5′;
and $180° - 60° 5' = 119° 55'$.

Then $\cdot165 \div 30 = {\cdot}0055 =$ versed sine of 6° 1′.

$119° 55' + 6° 1' = 125° 56'$; $\quad 119° 55' - 6° 1' = 113° 54'$.

$\dfrac{125° 56'}{2} = 62° 58' =$ arc of versed sine ·5454;

$\dfrac{113° 54'}{2} = 56° 57' =$ arc of versed sine ·4545.

$3 \div {\cdot}5454 = 5{\cdot}5$ inches = half the slide's travel;
and $5{\cdot}5 - 3 = 2{\cdot}5 =$ lap.

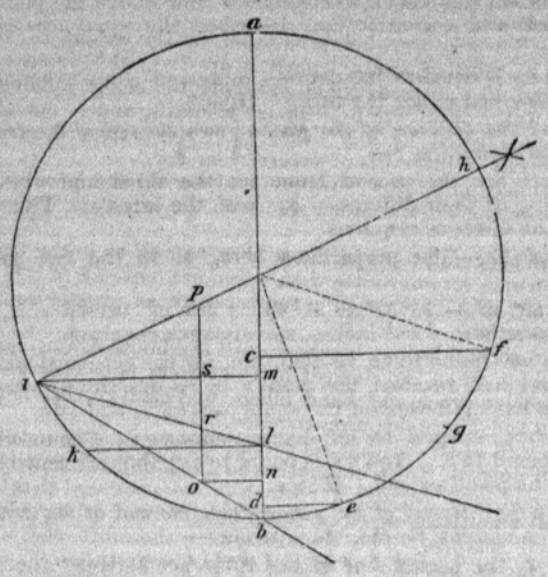
$\cdot5454 - {\cdot}4545 = {\cdot}0909$; and $\cdot0909 \times 5{\cdot}5 = {\cdot}5$ inches = lead.

To find the Lap and Lead by Construction.

The stroke of the piston; width of steam port; and distances of the piston from the end of its stroke when the steam is cut off, and when it is re-admitted for the return stroke, being known:

Let the circle (diagram 6) represent the crank's orbit, and its diameter *a b* the stroke of the piston, to some known scale. Make

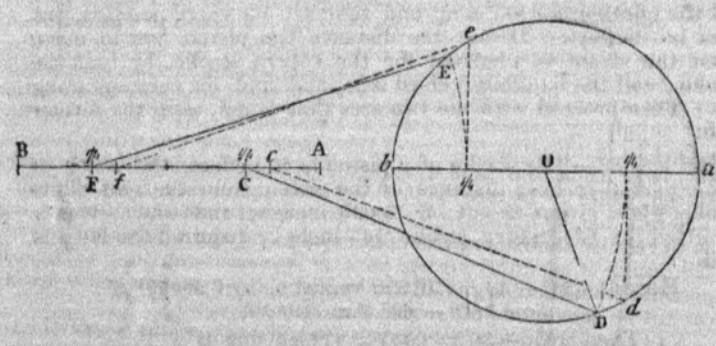
Diagram 6.



a c equal to the part of the stroke performed before the steam is cut off; and *b d* equal to the distance of the piston from the end of its stroke when steam is re-admitted for the return stroke. Draw *d e* and *c f* at right angles to *a b*, and mark the point *g* at the distance *b e* from *f*. Bisect the arc *a g*, and from the point of bisection, *h*, draw the diameter *h i*. Make *i k* equal to *b e*; draw *i m* and *k l* at right angles to *a b*; and draw *i l* and *i b* indefinitely. From the point *m*, set off *m n* equal to the width of steam port, full size; from *n* draw *n o* parallel to *i m*, and meeting *i b*, and also *o p* parallel to *a b*, and meeting *h i*: then will *s p* equal the lap, and *s r* the lead.

In all the foregoing cases, we have taken the versed sine of the arc described by the crank, from either extremity of the stroke, as the portion of the stroke performed by the piston; but, as has been already observed, the relative positions of the piston and crank depend upon the length of the connecting-rod, which will be seen by reference to diagram 7, where A B represents the stroke of the piston, C D the connecting-rod, and D O the crank. Now,

Diagram 7.



by supposing *a d* to be the arc described by the crank when the piston has performed one-fourth of its stroke, and from the length of that arc, calculating the amount of lap required to cut off the steam at that part of the stroke, we appear to be in error—for, from the oblique action of the connecting-rod, the piston would have descended only to the point *c*. But the engine being double-acting, we have to take into consideration the position of the crank when the piston has performed one-fourth of its stroke in the opposite direction from the point B: and here we find, that by supposing the crank to have described the arc *b e* (equal to *a d*), instead of the true arc *b* E, we cause the steam to be cut off when the piston has reached the point *f*; and the distance B *f* being precisely as much more than B F as A *c* is less than A C, the seeming error is self-corrective.

A Table of Multipliers to find the Lap and Lead, when the Steam is to be cut off at ½ to ⅞ths of the Stroke.

The Lap must be equal to the width of the steam port multiplied by Col. 1.
The Lead must be equal to the width of the steam port multiplied by Col. 2.

Half-Stroke.		Five-Eighths of the Stroke.		Three-Fourths of the Stroke.		Seven-Eighths of the Stroke.		
1	2	1	2	1	2	1	2	
Lap	Lead	Lap	Lead	Lap	Lead	Lap	Lead	
2·41	·000	1·58	·000	1·000	·000	·540	·000	·00000
2·16	·145	1·41	·124	·893	·105	·477	·089	·00208
2·06	·198	1·35	·170	·851	·146	·450	·123	·00416
1·94	·268	1·27	·231	·795	·200	·413	·170	·00833
1·84	·318	1·21	·276	·754	·240	·385	·204	·01250
1·77	·358	1·16	·312	·723	·271	·363	·232	·01666
1·71	·391	1·12	·342	·691	·299	·344	·257	·02083
1·65	·420	1·08	·368	·668	·322	·327	·277	·02500
1·60	·444	1·05	·391	·644	·343	·313	·296	·02916
1·56	·467	1·02	·412	·623	·362	·298	·313	·03333
1·48	·505	·968	·449	·586	·396	·273	·343	·04166
1·41	·540	·921	·480	·554	·425	·251	·370	·05000
1·35	·570	·881	·508	·526	·451	·232	·393	·05833
1·30	·595	·844	·532	·500	·473	·215	·414	·06666
1·25	·617	·810	·554	·476	·495	·198	·434	·07500
1·21	·638	·779	·572	·454	·514	·183	·452	·08333
1·17	·657	·751	·592	·434	·532	·160	·468	·09166
1·13	·674	·724	·607	·415	·548	·156	·483	·10000

The distance of the Piston from the end of its stroke when steam is re-admitted for the return stroke being equal to half the stroke multiplied by

Example of its application.—Stroke 36 inches; width of port 2 inches; steam to be cut off at half-stroke; distance of the piston from the end of its stroke when steam is re-admitted for the return stroke, 1·5 inches.

$\frac{1{\cdot}5}{18} = 0833$. Find that number, or the one nearest to it, in the right-hand or last column, and take out the multipliers on the same line under the head Half-stroke.

Then $2 \times 1{\cdot}21 = 2{\cdot}42$ inches = the lap.
And $2 \times {\cdot}638 = 1{\cdot}276$ inches = the lead.

R. B. C.

HEALTH OF TOWNS COMMISSION.

We may seem to be rather late in noticing the first report of the Metropolitan Sanitary Commissioners, but the first number of our new volume was so filled with other matter, that we were unable to do more than to call attention to the unfair way in which the profession has been treated by the commissioners and the government. Since then we are sorry to find that the design of employing military engineers in making the survey of London is persisted in, and that at a time when numbers of experienced and well qualified surveyors in the metropolis are without employment.

The first part of the Report is devoted to a consideration of the means necessary to resist the cholera. After a careful investigation, they come to the conclusion, which appears to us to be well founded, that cholera is not contagious, and that the great means of lessening its ravages are to be found in improved sanitary arrangements, particularly in connexion with the sewage.

To improve the sewage is their first step, and they have recommended and obtained the revocation of the old commissions of sewers. This is a measure to which we have already given our strongest advocacy, but we do not think that the commissioners have gone far enough. The Regent-street and Regent's-park district remains a narrow slip, running up from the Thames across the drainage of the Westminster and Holborn districts, and having a grand and deep sewer of nearly the capacity of the Fleet, which being employed as an outfall, would as we have before pointed out be immediately available in improving the drainage of a very large district. It is true that this is under the virtual jurisdiction of the Commissioners of Woods and Forests, but the commission ought to be at once revoked, and the jurisdiction transferred to the new metropolitan commissioners. The maintenance of this commission by the government is a reason which will be used for the maintenance of the City of London Commission, which is likewise left untouched, because, as the commissioners say, they have not had time to look into the case, but because, as we presume, Mr. Lambert Jones prevented it, and because the commissioners did

not choose to get themselves involved in a contest with the corporation of London.

The City Commission of Sewers has certainly been among the best managed, and this, perhaps, for the reason that they have always had a regular corps of officers; but still there is no reason why the city should not derive the benefit of an amalgamation with the rest of the metropolis. Let the corporation choose a commissioner, and they will get a share of the influence, control, and patronage, as well as of the economy attendant on the new commission. If they do not accede at once they will not be able to secure the few dinners which they receive, while they will lose the power and patronage. At present the street sewers of the city are imperfect and unflushed, the gratings and gully-holes untrapped, the courts and alleys undrained, the footways and footpavements not cleansed, the house drains and cesspools in a dangerous condition, while the sewers convey miasma into most of the houses. The statistics of the city in the latter respect are most unfavourable, and show a fearful influence on the public health.

The commissioners have given such evidence as to the necessity of consolidating the districts, that on the strength of that evidence we call upon them to complete their measure of amalgamation. They say—

"Taking the works of cleansing as they now are, the preventive measure to which those works may be immediately applied with the greatest advantage is that of flushing. But to the general and effectual application of this most important operation, the state and separation of the several districts under the district commissions, presents itself as an insuperable obstacle; and, in fact, the operation of cleaning out the sewers by flushing them with water is in systematic use in only one of the upper districts, the Holborn and Finsbury district.

"One district may flush its sewers, but the operation will be at many points only a removal of a portion at least of the refuse into the sewers of the adjacent districts, unless the operation be continued through the intermediate districts to the outfall. The lower districts complain of being encumbered by the flushing operations in the upper districts.

"In the lower districts, which are flat, there are generally accumulations of refuse, and if in an upper district, which is under a separate jurisdiction, a part of the line of sewer is flushed to keep it free from deposit, the effect upon the lower district in which the flush exhausts itself, is to disengage more copiously the offensive emanations, for a time, by disturbing and adding to the deposit there, without removing it. Whilst the sewers of one district are left unflushed, or uncleansed, the emanations are driven by the wind into other districts, particularly from the deposits at the mouth of sewers in the lower to an upper district. When the sewers in the Holborn and Finsbury division have been clean flushed, it is stated that the inhabitants of that district, even up to the New River Head, have been annoyed by the currents of offensive gases up the sewers from the accumulations in the lower districts, where the same cleansing operations have not been carried on. For obvious reasons, additional supplies of water would require to be provided in the upper districts, and regulated, for application throughout the whole lines to the outfalls, without staying for separate and intermediate co-operation."

One great evil of the present system, and a cause of fearful expense, is the disproportion between the area of the sewage sent through sewers and the area of the sewers themselves.

"Works to effect town drainage must be constructed for the removal of surplus or waste water from two sources; the natural rain-fall on the town area, together with water from the springs derived from sources beyond the area which may often require separate arrangements; and the pipe-water, brought into the town, and any refuse matter which it may have received in suspension or chemical combination. Setting aside for the present the consideration of the house drainage, and taking in the first instance, the secondary sewers, we give the following cross section, fig. 1, of a sewer draining two or three streets comprehending between one and two hundred houses. The depths of the ordinary run of sewer-water when there is no rain, is only about three inches, and the depth of the increased run of water on the occasions of the greatest storms, just covered the invert.

"The cross section, fig. 2, is a section of a main line of sewer in the Westminster district, draining about 90 acres of town area. The ordinary run of sewer-water does not cover the invert, and on the occasion of the greatest thunder storm of which there is any historical record in the metropolis, namely, that on the 1st of August, 1846, the flow of water was only 2 ft. 3 in. deep.

"In general the flow of water in the collateral sewers of branch lines of street, even where all the houses drain into them, are mere dribbles, and rarely rise above the invert of the wide bottomed sewers as at present constructed, even in streets where all the houses drain into the sewers. The following are the consequences which take place in various degrees in nearly all the collateral sewers of every form of construction, though the best is the egg-shape form.

"The flow of water, being impeded, by the extent to which it is spread, is retarded, and a deposit is created; this deposit becomes indurated to a degree which prevents its being removed by the flow of water occurring in ordinary rainfalls, and is not often considerably affected by any other than the extraordinary storms which occur in intervals of several years.

"The accumulations continue, and during the process, the deposit from the house drains spreads on the sides, and decomposition ensues.

"The accumulations in the sewers, as well as in the large house drains which communicate with them, are exposed to the action of much air, usually at such a temperature as greatly to facilitate decomposition.

"The accumulations increase until the house drains are entirely stopped up, when the deposit in the sewers is usually removed by the offensive process of hand labour and cartage, leaving the deposit in the house drains untouched."

It is well observed that very small currents suffice to keep sewers clear of deposit, if the inclination be good, and the flow be concentrated and kept regular, for which it is considered that additions of small quantities of water would be sufficient at particular intervals and seasons. The commissioners therefore recommend the use as far as possible of glazed earthenware tubes. These were long since tried by Mr. Roe in the Holborn and Finsbury division, and afterwards by Mr. Phillips in the Westminster division, and found to discharge the water more quickly and to keep clear of deposit. They also prevent the passage of rats from the sewers into houses, because they afford no hold, and do not, like the common brick drains, allow them to make burrows.

Mr. Roe and Mr. Phillips also made observations on the flow of water from the main and side sewers and drains, which the former began so long as five years ago.

In Mr. Roe's experiments he ascertained the rate of flow of water, through the common brick drains for houses, as well as through earthenware drains of the same capacity, and with the same run of water. As a general result it may be stated that the rates of discharge through earthenware pipes are very much increased, sometimes as much as one-third. In the application of water for flushing, this is an important consideration, as by the use of the improved drains, a great saving of water will be effected.

The house drains receive the water from small 1½-inch lead pipes from the kitchen sinks, and yet they are often made as much as 60 times the capacity of the pipes in the smaller houses. In these, square brick drains are put in, costing from 6*d.* to 11*d.* per foot run, exclusive of digging, while in the larger houses brick barrel drains of 9 or 12 inches diameter are put in, costing 1*s.* 4*d.* or 1*s.* 7*d.* per foot run. As the bottom joints are put in without mortar or cement, the sewer water percolates through the drain, and infiltrates into the houses, while the solid matter, unwashed by any stream of water, festers at the bottom, and acts as a retort for supplying nauseous gases to the houses. It is true that the object in leaving the bottom of the sewers "dry," or without mortar, is to let in the land drainage, but the effect is what we have stated, while it is rare to find a house drain free from deposit. The rats, too, by burrowing in the drains, put them out of order, so as to require their more frequent repair, and the whole working of the drains is as unfavourable as can be conceived, and as far as possible from the designs of the builders. A common house drain cannot be considered otherwise than as a nuisance.

A twelve-inch drain is an expensive nuisance, while an earthenware pipe of four inches diameter (or, proportional to the house, of from three to six inches diameter,) keeps perfectly clear, and a three-inch pipe is found quite large enough to carry away the refuse from middle-sized houses. In consequence of the adoption of this improvement, the cost of drains from houses to sewers in the Westminster division, which used to be from £10 to £25, has been brought down to a charge of from £2 15*s.* to £4 10*s.*, and even this is considered too high.

Nothing shows the error of the old system more strongly than a case given by Mr. Phillips of drains in Langley-court, Long-acre. An old small sewer, 18 in. wide by 2 ft. high, having a good fall, was nearly clean, while a new sewer, 5 ft. 6 in. high by 3 ft. wide, contained an average depth of three feet of soil, and the emanations from it caused the death of a poor man, and led to an inquest.

We think Mr. Phillips fully justified in stating [p. 30], that the sewers are bad in construction, but the house drains are worse. He states that in going along the sewers, he has often tried whether the currents of air were flowing into the sewers, or out of them into the houses. By placing the light which he had in his hand by the side of the house drains, he almost invariably found the flame carried into the mouths of the drains—showing that there must have been direct currents from the sewers through the house drains into the houses. Many of the gully drains showed an outward current into the streets, though some have a downward draught.

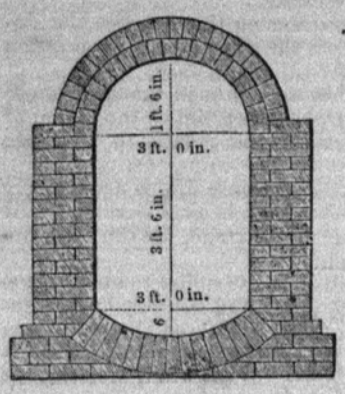


Fig. 1.

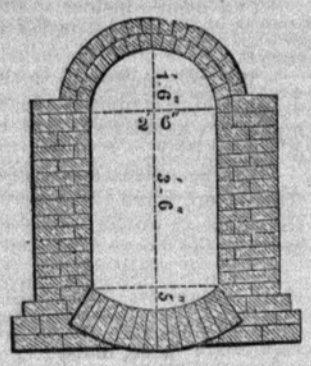


Fig. 2.

Mr. Phillips gives his support to the statement that some neighbourhoods are at times afflicted with more noxious effluvia from the sewers, than if there were no sewers whatever. He thinks the great remedies are to keep a constant supply of water in the sewers, and to circulate it through them; and to carry all the outlets under the side beds of the river, to discharge into the main stream under low-water level. Mr. Phillips has found that the atmosphere of districts near the outlets of the sewers is liable to be affected with effluvia, when the wind happens to blow up the sewers. By carrying the outlets into the stream, he expects, moreover, to get rid of the filthy mud-banks, and the myriads of worms sweltering upon them.

The Report notices the extended use of the egg-shaped sewer in the Holborn and Finsbury and Westminster divisions, but remarks that the new sewers constructed are generally of the same internal capacity as the old forms, and therefore disproportioned to the extent of the drainage. A further great saving will consequently be made in the new operations by reducing the size of the sewers. The commissioners observe, with justice, that the mere view of the ordinary run of sewer water in the sewers, or of the run of water on the occasion of heavy storms, might have led to some amendment in the construction of sewers without any gaging, had a view been taken of the flow in the lateral, as well as in the main lines of sewer; but the sizes of all classes of sewers have been maintained on the view of the main lines alone. Mr. Hertslet, the clerk to the Westminster commission, well observes that he has been perfectly at a loss to conceive, in traversing the sewers, why such immense sewers should be built to carry off such mere threads of drainage. He has seen sewers 5 ft. 6 in. high by 3 feet wide, built where, even during heavy rain, a 3 or 4-inch pipe would have carried off all the water.

Mr. Phillips makes some curious remarks with reference to the size of current which would suffice to keep an ordinary sewer clean. In passing through the branch sewers, he has noticed that the currents of water are mere dribbles, and being spread over a flat surface are not strong enough to remove the soil. Looking at the currents, and comparing them with the extraordinary sizes of the sewers, it was easy to decide that the currents might be passed through pipes of from 3 to 9 inches diameter. Indeed, in a large number of the sewers, the currents have cut narrow and deep channels for themselves, leaving the bulk of the deposit untouched, but showing, as Mr. Phillips says, that nature was trying to remedy the faults of art. Sometimes it is necessary to cut such channels through the deposit, to allow of the flow of water. Acting upon this view, Mr. Phillips proposes to improve the flat-bottomed sewers, by bedding channel tiles along their bottoms, and filling them in behind with concrete, In the middle he would place a channel tile of say 1 foot diameter, having other flat tiles sloping down to it on each side. By this means, the currents would be concentrated on smaller sized channels, kept regularly in action, and therefore clean.

Mr. Roe proposes to reduce the expense of sewage for one side of a sewer for a house of 17 feet frontage, which lately with upright-sided sewers was £9 11*s.* 3*d.*, and now is with egg-shaped sewers £6 0*s.* 5*d.*,—this he proposes to reduce to £2 19*s.* 6*d.* for first-class houses, and £1 14*s.* for sixth-class houses. In these latter charges is included the supply of water. The bottom portions of the larger sewers Mr. Roe proposes should be of well-prepared clay, moulded in blocks two feet long, and well burnt; the upper portions to be formed of radiated bricks, laid in blue lias mortar. The smaller sewers are to be likewise egg-shaped, but to be made entirely of brown stone-ware glazed. Mr. Roe's first-class largest sewer is 3 ft. 9 in. by 2 ft. 3 in., with an area of 6·6 feet, and costing 7*s.* per foot run; his seventh-class, or smallest sewer, is 15 in. by 9 in., with an area of 9 inches, and costing 3*s.* per foot run.

The greater part of the duties of the officers, Mr. Roe states, is taken up by attending to complaints of the stoppage of drains and sewers, and in superintending the removal of the soil; when, with a proper system of sewerage and house drainage, nearly the whole of the duties in that respect may cease. We agree with him that it is far better that a staff of officers should be constantly engaged in making examinations, in order to prevent filth from depositing and accumulating, than in waiting for it to collect and annoy the public with its noxious emanations, perhaps for weeks and months before complaint is made and steps are taken to remove the evil.

We think a great deal may be done by Mr. Guthrie's plan, mentioned in the *Health of Towns Magazine*. In this he proposes to separate the house drainage from the surface drainage. The house drainage being conveyed in tubes, as stated by Mr. Roe, would, under the pressure of water, be carried to the outfall, without gully holes or other communications with the external atmosphere. The surface drainage in the secondary streets could be conveyed by the kennels, and in the main streets be received by the large sewers.

The commissioners come to no decision, at present, as to the use of chimney shafts, with currents of air created by heat, for ventilating the sewers and carrying off the noxious emanations, though they express their approval of the principle.

In conclusion, we must again urge upon the commissioners the necessity of coming to some immediate decision respecting the use by the public of all sewers which have been built at the expense of the commissions, and at once abandon the extortionate demand of 10*s.* per foot run on the frontage of a house, which, if it happen to be a corner house, may amount to the sum of £20, besides £5 more for making the drain, for a fourth-rate building that cost only £200. Every facility and encouragement ought to be given to the owners of house property to make drains into the public sewers, and so to abandon the pest of cesspools.

CANDIDUS'S NOTE-BOOK
FASCICULUS LXXVIII

"I must have liberty
Withal, as large a charter as the winds,
To blow on whom I please."

I. Some have acquired a reputation for having a style of their own, merely because they have repeated the very same ideas over and over again, on occasions the most dissimilar; and, so far from improving upon them, that their latest applications have been less appropriate and judicious than their earlier ones. Such decided mannerism ought rather to be taken not so much for consistency of style as for sterility and inactivity of mind. He who at all deserves the name of artist—and architects claim it by courtesy, at least—is always enlarging the stock of his ideas, and is always studying, throughout the whole of his career. Without copying others he profits by what they have done, both by shunning the faults they have committed, and into which he himself might have fallen but for such evidence of them, and by borrowing from them hints and *motifs*,—after a very different manner, be it observed, from the mere plagiarist. There is no merit in not availing ourselves of ideas thrown out by others, more especially if it has been done so very imperfectly and at random, that very much more than was at first thought of remains to be made of them. "He," says Reynolds, "who resolves to ransack no mind but his own, will

soon be reduced, from mere barrenness, to the necessity of copying himself."—Unvaried uniformity of ideas is not so much a sign of consistency as of limited power of conception and expression, and, moreover, occasions not only wearisome repetition but inconsistency likewise, the same mode of treatment being resorted to upon occasions and for subjects totally dissimilar from each other.

II. "How many of us country architects," says Mr. Sharp, "are forced to take the counsel of our excellent friend, Percier, and in despair of executing large works, to bestow greater care upon lesser ones?" Well was it that the remark was put interrogatively instead of affirmatively, for in the latter case it ought to have been, not "How many," but "How few." Were Percier's excellent advice to be followed by country architects—and for the matter of that, by town ones also,—did they invariably strive to make the utmost of the occasion offered them, however inconsiderable it may be in itself, there would be far less of slovenly or else downright trumpery design than there unfortunately now is. The "making the most" of the occasion must not be misinterpreted: it is not to be understood as recommending or consisting in ambitious aim and pretentiousness of design, and in mimicking larger things, as is frequently very absurdly done now, but on the contrary, in attempting no more than can be thoroughly accomplished, and so well accomplished that for intrinsic merit of design and captivating effect the work may not only vie with, but surpass many others of greater note in ordinary estimation—chiefly, perhaps, because their size alone renders them conspicuous and imposing objects. Were this to be duly considered and acted upon, we should have less of vulgar architectural *swaggering*, and far more of real study of design, than we find now. It is precisely because there is so little of the latter, and because architects do not know how to impart to small or comparatively small buildings such character as shall be both striking and appropriate, that we have so much random copying, and injudicious imitation, which serves only to remind us of merits belonging to the original that are altogether missing in the copy.—There is much more room for fearing and also for saying that, taken in general, our smaller provincial buildings show, if not ignorance of design, very great negligence of it—sometimes to a degree almost incredible, if we may believe what profess to be portraits of them. The Masonic Hall at Cowes, and the new Ipswich Museum, are so far from bearing out what Mr. Sharp says, as rather to prove that architectural taste must be at the very lowest ebb in those places, if not in any other parts of the country. Such doings in the provinces are, it must be confessed, kept in countenance by similar Pecksniffian achievements here in town, one of the most egregious of them being the College of Agricultural Chemistry in Oxford-street, which, small as it is, is any thing but an architectural miniature, for it has neither the delicacy nor refinement of one, but is no better than a vulgar and coarse architectural daub. Exceptions there are; and for one of them, we may point to the elegant screen façade of Dover House; or, to take a quite recent one, there is Mr. Hodgkinson's newly-erected house in Park-lane, which affords striking evidence of what may be done within a very limited space —how much beauty of composition and elegance of detail may be displayed in a narrow frontage.

III. Music has, perhaps, been far more fortunate than Architecture, having escaped from the surveillance and trammels of archæological pedantry, in consequence of no musical compositions of the ancients remaining. No doubt they were altogether different in style from anything in modern European music; therefore, had they been preserved and followed as wholesome *precedents*, would have checked rather than at all advanced the progress of the art in later times. To say that had the architecture of the Greeks and Romans perished as well as their music, it would have been all the better now for the former art, would incur for me the epithet of ultra-reprobate, and would, besides, be doing violence to my own feelings. Yet it is sincerely to be wished that its examples were studied more, and aped less,—studied rationally and æsthetically; and then it would be perceived that admirable as they are in themselves, and with reference to the purposes for which they were erected, they are either ill-adapted to, or furnish but very little towards, such an enlarged and complex architectural system as we now require. For actual practice, they afford us little more than a few varieties of column and entablature, arches, pediments, and such features, in regard to which we pique ourselves upon scrupulously adhering to the authority of some one particular antique example, although the structure to which they are applied is in its composition and physiognomy the very reverse of antique. As I have said, I believe, more than once before, modern architects have converted the orders into mere *patterns*, from which they have only to choose, without being put to the trouble of shaping out a single idea of their own. So that as far as the orders are concerned, they neither are nor are called upon to act as artists at all; and as to the merit of truthful copying, that belongs rather to the operative stonemason than to themselves. There are many ancient examples that might be modified to greater or lesser extent, and in a variety of ways, without losing sight of the character of the type so followed. Nay, some might be considerably improved upon, and more consistently finished up than they appear to have been, unless they have been greatly mutilated. Take, for instance, the Ionic order of the Erechtheum,—surely such an exceedingly simple and severe cornice accords very ill indeed with such luxuriantly rich capitals, which seem to demand a corresponding florid character in what is the corresponding division of the entablature, and the crowning to the entire order. Together with want of keeping as to character, there is a falling off of effect where it ought, if any thing, to be increased rather than at all diminished. Obvious as this appears to myself, not one of those who have taken that example have ventured to depart from the exact letter of it, by supplying such a cornice as would complete and perfect it. Of the two, even an exaggerated cornice is a more pardonable fault than a starveling one. The reproach of heaviness is preferable to that of poverty and meanness.

AIR-TIGHT GRANARIES.

Three conditions are essential to the process of putrefaction of grain, viz.: heat, moisture, and still air. With wind, moisture is carried off; with cold, the decomposing process is checked, as may be seen by the carcases of animals that lie through the winter in snowy mountains, and dry up to glue. Without air, everything is locked up and remains *in statu quo;* as reptiles have been buried for ages in blocks of stone or ancient trees, and then resumed their vital functions, unchanged by time. In direct opposition to these principles are the granaries of Great Britain and other countries constructed. Their site is generally the bank of a river, or the sea side. They are built of many floors, at a vast expense. Men are continually employed to turn the grain over, to ventilate it, and clear out the vermin; and the weevil is naturalised in every crevice, as surely as bugs in neglected London beds, or cockroaches in West Indian sugar ships. It is the admission of air that permits this evil, that promotes germination, that permits the existence of rats and mice. In the exclusion of air is to be found the remedy. Granaries might be constructed under ground as well as above ground; in many cases, better. They might be constructed of cast-iron, like gasometer tanks; or of brick and cement; or of brick and asphalte, like underground water-tanks. It is only required that they should be air-tight, and consequently water-tight. A single man-hole at the top is all the opening required, with an air-tight cover. Now, if we suppose a large cast-iron or brick cylinder sunk in the earth, the bottom being conical, and the top domed over; an air-pump adjusted for exhausting the air, and an Archimedean screw pump to discharge the grain, we have the whole apparatus complete. If we provide for wet grain, a water-pump may be added, as to a leaky ship. Suppose, now, a cargo of grain, partly germinating, and containing rats, mice, and weevils, to be shot into this reservoir, the cover put on and luted, and the air-pump at work, the germination would instantly cease, and the animal functions would be suspended. If it be contended that the reservoir may be leaky, we answer, so may a ship; and if so, the air-pump must be set to work just as is the case with a water-pump in a leaky ship. One obvious cheapness of this improved granary over those existing is, that the whole cubic contents may be filled, whereas, in the existing mode, not above one-fourth of the cubic contents can be rendered available. But many existing structures might be rendered eligible. For example: the railway arches of the Eastern Counties, the Blackwall, and the Greenwich. Reservoirs might be erected in farm yards, or inasmuch as it is a certain thing that all farms must ultimately communicate with railways, by means of cheap horse-trains, or steam sidings, in order to work to profit, it would be desirable that the granary should be erected at some central railway station, where a steam mill would do the work of exhausting the air, discharging the grain by Archimedean screw when required, and grinding it into meal. No better purpose could be found to which to apply the atmospheric engines and stations of the Croydon Railway, with their existing air-pumps. Communicating with all the southern wheat-growing counties of England, and also with the Thames, no spot could be more eligible as a central depôt.—*Westminster Review.*

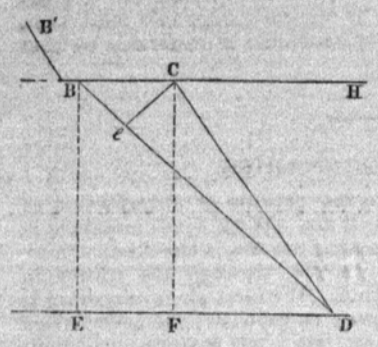
ON WING WALLS OF BRIDGES.

By R. G. Clark, C.E.

As the drawing of wing walls to railway bridges offers some difficulty when the embankments or cuttings are very high, to obviate this is the object of the present paper, which relates to the investigation of some simple formulæ to determine the angles made by the exterior lines of wing walls with the face of a bridge; the plane of projection being taken on a level with the rails or road, when the latter is level.

There are two cases to be considered.—1st. When the coping of the wing wall makes a given angle with the face of the bridge, or is parallel to the abutment, as in the case of a skew bridge.—2ndly. When the coping is perpendicular to the face of the bridge.

1st. Let B H be the line of the face of the bridge on H B E D, the plane of projection as before mentioned; C D the exterior top line of wall; C e the given batter, perpendicular to B D. The $\angle$ H C D being given, or D C drawn parallel to B B′, as in the case of a skew bridge, draw E D parallel to B H; and BE, CF, respectively, perpendicular to E D. For the sake of simplicity, we will first determine the $\angle$ C D B.



Let the slope of embankment or cutting be as m to 1, and the batter of wing wall as 1 to n; height of slope equal h. Now, $\angle$ C D E = $\angle$ H C D. Let $\angle$ C D E = θ. Also, base of slope C F = mh; and batter C e of wing wall = $\frac{1}{n}h$.

Then, by the right-angle triangle C F D, we have

$$\sin\theta : mh :: 1 : \frac{mh}{\sin\theta} = \text{D C}.$$

Also, by triangle C e D, right-angled at e, we have

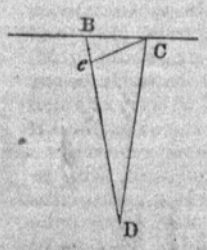
$$\frac{mh}{\sin\theta} : 1 :: \frac{1}{n}h : \frac{\sin\theta}{mn} = \text{nat. sin } \angle \text{C D B} \ldots\ldots\ldots\ldots (1).$$

$$\therefore \angle \text{H B D} = \angle \text{H C D or } \angle \text{C D E} - \angle \text{C D B}.$$

Example. Given the angle of obliquity H C D = 20°, slope $1\frac{1}{2}$ to 1, and batter 1 in 5, to determine the angle of wall H B D:

By formula $\frac{\text{nat. sin } 20^\circ}{1\frac{1}{2} \times 5} = \frac{2 \times \cdot 34202}{15} = \cdot 04560 = \text{nat. sin } 2^\circ\, 37\frac{1}{2}'$;

therefore, $\angle$ H B D = 20° − 2° 37½′ = 17° 22′ 30″ required.



2ndly. *When the coping is perpendicular to the face of the bridge.*

Then $\sin\theta = 1$;

consequently, $\sin \angle \text{C D B} = \frac{1}{mn}$.

Hence, $\cos \text{C B D} = \frac{1}{mn}$ ..... (2).

Examples.

When the slope is 1 to 1, and batter 1 in 5.

Then nat. cos $\angle$ C B D = $\frac{1}{5}$ = ·2 = nat. cos of 78° 27′.

When the slope is $1\frac{1}{2}$ to 1, and batter 1 in 5.

Then $\angle$ C B D = 82° 20′.

When the slope is 2 to 1, and batter 1 in 5.

Then $\angle$ C B D = 84° 15′.

From the above it appears, that the actual height of the slope, and the batter in feet, &c., have no occasion to be taken into consideration; but only their respective ratios, as above given.

RAILWAY AND STEAM NAVIGATION DEFENCES.

The course which the Duke of Wellington has thought fit to take, in furtherance of the measure of increasing the army under his command, has given a new strength to the alarmist party. We say, advisedly, that the Duke's letter to Sir John Burgoyne can only be taken as the statement of an advocate, using every means to make out a case; for there is evidence enough in that letter to show the impracticability of an invasion, if it were consistent to suppose that a commander so experienced could countenance a scheme, which the youngest staff-officer knows is in no way feasible. In considering the subject, we do not think it necessary to analyse the Duke's letter, because we do not look upon him as a believer in the invasion scheme; but we shall take up the question upon its own merits, which are certainly small enough, compared with the clamour which has been made by so many parties, and of which the Commander-in-Chief has so skilfully availed himself, to further the views of his own department.

It is one of the consequences of thirty-two years of peace, that the present generation know little of war or of military affairs, and it is therefore open to ignorant or restless officers to impose upon them statements, which do not meet with the countenance of men well informed in their own profession, and which are not consistent with historic proof. With the public an officer is taken as an authority in virtue of his epaulettes; but, nevertheless, he is as an officer no more an authority on this question of invasion, than the most ignorant civilian. It is one of the misfortunes of the English army, that there is no guarantee for the qualifications of its officers; and, notwithstanding the growing desire of improvement among military men, it cannot be denied that it is much rarer to find a man well acquainted with his profession than otherwise, for there is no security, and it may be said no encouragement, for proficiency. In the navy, and in the artillery, an examination must be passed; but, under the system by which the army is officered, except the few college cadets, a man may be put in command of an army, whose only qualification is that he can manœuvre a battalion on parade. Neither is the service of the English army calculated to qualify an officer for European warfare, for the staff arrangements even of an Indian campaign will give no schooling for a war in the old battle-field of Flanders. One of the defences we most want is a good staff of officers, and money cannot be better laid out than in enlarging the military colleges, and encouraging the studies of officers. In the meanwhile, we hope the public will not allow themselves to be frightened out of their wits by men who know no more of the organization of an army of fifty thousand men than a drummer-boy does; and, at any rate, to accept with caution any statements which have not the support of common sense and historical evidence.

It is very easy to start with the hypothesis of 50,000 Frenchmen on the Sussex coast, and to talk of the capitals of France, Austria, Russia, and Prussia having fallen into the hands of an enemy; but it is so difficult to conceive how a French army of 50,000 men, or of any other force, could be brought to London, that any general being offered the command of such an expedition, would give it up in despair. In order that a French army may land upon the English shore, there must be no political disorganization in France, and there must be political disorganization in England. Our great protection hitherto against invasion from France, has been the political disorganization of that country by the League, the Protestants, the Camisards, the Girondists, or the Chouans, or by the irruption of Prussians, Spaniards, or Savoyards. Napoleon never hoped to be able to make an effectual invasion of this country, unless he could make a political diversion, by securing the neutrality of parties in opposition to the government. How futile was that dependence is well known; and though some may, in the present time of calm, believe that political factions might hereafter be brought to sympathise with an invader, yet such coalition would become impossible when war shall break out, and the old feelings of bitter hatred be awakened. This is a disturbing influence which cannot be readily overcome. There is nothing more difficult than to overcome a people in their own country, with whatever force, if united in resistance. France will give the example. If, in 1814 and 1815, the allies were able to make their way to Paris in the then political disorganization of the country, yet, in the early part of the war, under the Duke of Brunswick, though France was unprepared, the invaders were driven back with loss.

The circumstances under which an invasion of England will be practicable are—the union of the French, High Dutch, and Russians, the destruction of the naval power of England, our political disorganization, and the agreement of a large part of the people

to welcome the invader. This country has not yet had an enemy on its shores, and it is not to be judged like France, Flanders, Holland, Italy, Germany, and Spain.

Before coming to our own particular view of the question, we have a few observations to make upon the military and naval part. The hypothesis of an invasion must be under these forms:—of an army of 200,000 men, or of an army of 50,000; of an army with cavalry, artillery, pontoons, provisions, and train, or of an army with light mounted artillery. Confining ourselves to an army of 50,000 under either of the latter two conditions: such an army, with 10,000 horses for cavalry, 400 or 500 pieces of artillery, horses and carriages for artillery, ammunition, provisions, and train, would require greater steam accommodation, and take greater time in landing. It would, consequently, defeat itself, by giving more time for the muster of forces against it. On the other hand, a mere incursive light force of 50,000 men, would be defeated by want of means to overcome the usual obstacles of delay. It would want cavalry to drive off the swarms of local mounted skirmishers, and to make its reconnaissances; it would want means of crossing rivers; and when its brigades before concentration were brought in front of a regular force in position, it would want heavy cavalry and artillery. If the wounded men were picked up they would encumber the march, and if left behind they would be massacred by the local skirmishers hanging on the rear; so that the men would soon become demoralised. Three days' stay in a wasted country would leave such an army, even if concentrated, without provisions or ammunition, with its ranks thinned and dispirited by death and fatigue. If it attempted to fight, every man would be butchered. Indeed no worse fate can be wished for any man than to have the command of a brigade in an army of invasion of England.

Persons who are ignorant or ill-advised, may say that we have no regular force and no military spirit in the country; but those who take the trouble to calculate know that this country has at all times had great military resources, and at no time so much as at the present. Turn back the pages of the history of England, and watch the progress of preparation. The regulars in England are increased by scores of thousands at a time; sixty thousand militia are embodied and used as regulars; an army of reserve is called out; local militia are brought into the ranks of the regular army; three or four hundred thousand volunteers are enrolled; and, in 1808 for example, seven hundred thousand men are in arms in the islands, besides a vast fleet patrolling around. Since then, the population has doubled, and that seven hundred thousand men will become a million and a half, with the levy *en masse* to back them. England, without allies, can never be lost, if only true to herself, though the nations of Europe should be poured on her shores. No enterprise could be more dangerous than to land troops in a thickly-peopled country, among a brave and warlike population, strengthened with all the resources of knowledge and wealth. For what would this to be attempted? To take the land, but to fill the shores of the Atlantic, and the waters of the deep, with a fierce people, who, as the Hollanders once threatened to do, would take to their ships and seek a new country, whence they could turn upon their oppressors.

It should be noted that it is an old regulation, always renewed in time of war, that in case of invasion, all corn, cattle, and people, within twenty miles of the shore, must be driven up the country, and the district wasted, and efficient means are provided for effecting this. England in time of war, and England in time of peace, are different countries, and it is certainly not matter of blame that the government, in the thirty-second year of peace, do not harass the country with the troubles of war-time. Why are martello towers, shot furnaces, and batteries to decay upon the coast, heavy artillery to rust, and men to be taken from their shops and homes to the drill ground, when all that is wanted in this way can be done when the time comes?

As to sudden invasion at this moment, it is a bugbear; but we are always ready to urge that a consistent system of preparation for war shall be carried on: but then in our opinion the means are simpler than those usually put forward, and are not to be sought in the army estimates, but more immediately within the scope of what are commonly called the engineering operations of the country. We do not advocate an increase of the standing army; we have no faith in the fortification of Portsmouth, Plymouth, and other towns, as strong places; we do not think it necessary to lay down batteries on the coast, or to mount them with heavy artillery; still less do we advocate the calling out of the militia. We may observe, that the government of this country have always wisely shown an indisposition to put arms into the hands of the people in time of peace, because they are not under the bond of a feeling of hostile invasion, which in time of war prevents a misapplication of arms to interference in the civil government.

We consider that a due attention to railways, steam navigation, and the telegraph system, will in time of peace be the most efficient means of providing for the defence of the country. We are no longer in the position we were a few years ago, when the sudden growth of steam navigation threatened military and naval men with a new instrument of aggression, against which they had no means of defence. Then there might have been occasion for alarm, had war broken out; but since then, the development of the railway system has provided an adequate power of resistance; while, more recently, the establishment of electric telegraphs has thrown the scale of preponderance in favour of the defensive resources. We can no longer be in doubt in what direction we are to apply our means and make provision. We must avail ourselves of those three great branches of national enterprise which we have already named. Do not let any think us over-professional in taking this view of the matter, for this is the side on which the Duke of Wellington looks at it. He takes his case on a steam-navigation invasion, on this new development of scientific resources; and the fair way to meet it is to consider what resources of such kind are available for the purposes of defence. Engineers and manufacturers have created the means of invasion, and they must provide us, to some extent, with the means of defence.

Considered in reference to the defence of the nation, nothing can be more unwise than that legislative interference which has restricted railway enterprise. Even were it true that there was an undue competition for railways, and that capital was diverted into this branch of investment, still, so far as the country is concerned, it is desirable that as many railways as possible should be made. If we are asked whence the capital comes for railway construction, we can have an answer which springs from the very matter now under discussion. In time of war, we keep a couple of hundred thousand regulars and militiamen, giving no productive return. In time of peace, we can employ two hundred thousand navigators, or, in reference to our present means, four hundred thousand navigators, in making railway works. At present, out of an income of fifty-five millions, thirty millions are a mere transfer of capital, in the shape of interest on the debt; the remainder is the effective drain upon the energies of the country; and every addition of twenty thousand men to the military forces is a deduction of so many men, and of one million yearly, of so much productive labour and capital rendered unproductive. We can carry on such great railway works while other countries cannot, because France, for instance, keeps three hundred thousand, or four hundred thousand, men under arms,—doing no good, but, on the contrary, weakening its resources.

The less interference with railway legislation and management the better, for it results only in public inconvenience. Had it not been for this interference, we should now have had coast lines all round the island, and been provided with sufficient converging lines from the great seats of population. As we stand now, the southern coast line is incomplete, the line to the west coast is incomplete, the eastern coast is neglected, and indeed the communications are left in such a state, that in time of war they will require to be completed at the national expense. If erroneous views of policy had not prevented it, we should have had at present the following lines available for the south coast defence:—A line along the south bank of the Thames, to Dover, to Hastings, to Brighton, to Shoreham, to Fareham, to Portsmouth, and to Southampton, giving the means for pouring down troops most rapidly; whereas, through the fear of competition, we are left with the present inadequate accommodation. If the plan of traffic estimates and investigations had not been followed, and parliament had not undertaken the futile inquiry whether a line would pay or no, we should have had lines enough made by those who are the best judges how to invest their money. It is, however, the consequence of the meddling policy, that it always reacts to produce serious inconvenience to the country, without doing the slightest good.

Now that railway enterprise has been suppressed and knocked down, it becomes the duty of the government to aid the companies in carrying out the necessary works. Among them are the bridge over the Thames to connect the north and south railways; the branch of the Brighton railway from Croydon to Wandsworth; the union of the Portsmouth and Gosport lines; and the extension of the Brighton and Hastings line through Rye to Ashford. London is the seat of a population which will afford four hundred thousand able-bodied soldiers, between fifteen and sixty, to be poured down to any point of the coast between Dorchester and Harwich; and it is therefore necessary to provide accommodation

for bringing this great reserve to bear upon any point attacked. The metropolis also is the reserve for defending the whole of the northern and west coasts, in case of insufficiency of local force.

It has been recommended that the railway companies should be encouraged to adapt their wagons so as to carry heavy artillery; but this is unnecessary, though they should have provision for carrying light artillery. This country, yielding more than one million and a half tons of iron yearly, can supply any number of heavy carronades to carry 68 lb. hollow shot or solid red-hot shot. In case of need, a thousand carronades could be cast daily. The coasts can be lined with heavy ordnance, and provided with furnaces for heating shot, the guns being worked by the local fencible artillery. If the enemy effected a landing, the guns would be spiked and left on the spot. Guns would likewise be brought up along the line of the enemy's march, and upon the fortified lines and camps, and as each position was abandoned the guns would be spiked. There would be no object in lugging about heavy pieces, and the enemy would not move spiked iron guns, if they had the train to do it.

Every encouragement should be given to telegraph companies to lay down wires, for although we have got to a certain stage of advancement, the electric telegraph system in this country is far from being in a satisfactory state. It seems very desirable that it should not be left a monopoly in the hands of the Electric Telegraph Company or the government, who, by inveterate adherence to one system, may check the course of improvement. The use of the needle telegraph by the company we believe to be fraught with great inconvenience, and indeed, in particular conditions of the weather, as the needle telegraph will not work, it may become useless either to announce an invasion or to communicate orders. It is to be observed that the electric telegraphs for the south coast are in a bad condition. The coast line is not completed, and the South Devon line is said to work imperfectly. The telegraph on the South-Eastern is worked in a complicated manner; there is no telegraph on the Brighton. There is a telegraph on the South-Western; but on the Great Western, none beyond Slough. We say nothing about military communications with the inland stations, or with Chatham, Plymouth, and Milford. All this requires looking to, so that every encouragement be given to complete the system; and in case of need, the government must themselves lay down wires.

The steam navigation resources of the country must be cultivated by a prudent legislation. On this head, as on railways and telegraphs, private enterprise is ready enough to work without requiring any great expenditure on the part of the state; but, unhappily, legislation has generally been unfavourable to private enterprise, or so tardy, that private resources have been exhausted before public aid was afforded. The Great Western Steam Navigation Company was allowed to drop, when slight aid from the public would have given it an impulse, and we might had a weekly line to the United States before now. Mr. Waghorn is still urging upon the government the packet line to Sydney, and Mr. Wheelwright has not too much reason to congratulate himself on the aid afforded to Pacific steam navigation. From the tardiness of the government, the Great Western, the Cape of Good Hope, and the Bahia Steam Navigation Companies have been ruined, the Pacific Steam Navigation Company has been kept in difficulties, and the Royal Mail and Peninsular Companies long had to struggle amid depression and neglect.

The line to Australia should at once be authorised, as also one to the Brazils. Already a steam marine has sprung up in Sydney, and it would be much extended under the impulse of a steam communication with the mother country, while a slight encouragement would fill with steamers the harbours of our possessions on the Indian ocean, and greatly augment their defensive resources.

It is very desirable that examinations should be established for masters, mates, and enginemen of steamers, but accompanied with the distribution of such prizes for proficiency as should stimulate the acquirement of professional knowledge, and raise the character of the persons employed.

With a population of fifteen or sixteen millions on sixty thousand square miles, and with vast material resources, nothing but the imbecility of a government, or the treachery of a party, would make a foreign invasion possible; and one great source of moral strength and confidence is a knowledge of those resources. What can be more desperate than the embarkation of landsmen in steamers and small craft, which, if the sea-force of England be annihilated, must still be landed on a hostile shore under a well-directed fire of red-hot and hollow shot and shells from heavy pieces. By the time a landing is effected, the local force is mustered, troops pour in from all quarters, the people, cattle, and corn are driven, the roads and bridges broken up, and the enemy would have to advance under the fire of mounted and dismounted sharpshooters, lurking in a country full of hedges, ditches, and enclosures. Every bridge and culvert would form an obstruction, every grove of trees near the roads be cut down for an abattis; barriers would be formed at the hamlets and villages, and guns mounted in the churchyards, mills, and on the hill-tops. In the face of such obstacles the enemy would have to advance, each man carrying sixty rounds of ammunition and three days' provision. Tirailleurs would have to be thrown out around the column of the moving brigade, and, after two or three miles' advance, more must be kept in the rear, as the skirmishers would get behind, in order to slaughter the wounded, for it is well understood in such affairs that no quarter is given. The brigades landed at various points along the course, would have their communications interrupted by the deep and wide mouths of the rivers, and their progress impeded by gorges and steep passes in the chalk range, which would admit of a stand being made by the local forces. The brigades would not know whether their whole army had made good its landing, and would not in many cases know the fate of the brigades on their flanks; while, at the points named for the concentration of the divisions, many brigades would not be able to get up, and movements would be necessary in flank and rear to extricate brigades which were cut off and surrounded. Every hour lost to the invaders would be thousands of men added to the protecting force, and if divisions could be got together for an advance, they would then have to carry entrenched camps and fortified positions, against a superior force well provided with cavalry and artillery, and knowing that the carrying one strong position was only shifting the field of battle to another strong position in the rear. When it is considered that in a broken country, swarming with skirmishers, a force weak in cavalry could not keep up communications without moving such a body of men as could defend themselves and cut their way through, the demoralization of the invading force within twenty-four hours would be certain. A very hard day's work would have to be done; nothing would be known as to the fate of other portions of the force; many of the men would have become the victims of the infuriated skirmishers; and a night would come on, when a large force would have to be detached for piquets and outposts, of which the sentries would be picked off on their guards, while the outposts would be driven in by night attacks. The next morning would offer the choice of a surrender, a retreat, or an attack from a superior force; and this without having got more than twenty miles from the coast. This is rather a different picture from that drawn by Lord Ellesmere, of the guards marching out of London; but then it is the true one, which those who have had experience in such matters will recognise.

REGISTER OF NEW PATENTS.

PNEUMATIC SPRING.

Moses Poole, of the Patent Office, London, gentleman, for "*Improvements in the construction of pneumatic springs.*"—Granted May 22; Enrolled November 22, 1847. (A communication from a foreigner.)

The nature of this invention consists in applying the elasticity of atmospheric air, or any permanently elastic gas by means of air expanding and contracting chamber or chambers, made in one, two, or more parts, and connected together by means of two or more belts of india-rubber cloth or other flexible or impermeable material, with alcohol or other liquid interposed, the more effectually to prevent the escape of the gas or air contained in the apparatus, and to aid in relieving the flexible connexion, and preventing its rupture from the action of the weight or force on the spring.

This mode of connecting two vessels being applicable without the air to other purposes, such as hydrostatic presses, &c., by forcing the water into or between the two vessels.

And the improvement also consists in providing this apparatus with one or more of what is denominated a respiratory chamber or chambers, attached to one or both ends of the apparatus, and separated from the main chamber of the apparatus by a diaphragm or diaphragms perforated with holes, which will check the passage of the air, and thus relieve the apparatus from the injurious effects of sudden shocks.

The manner in which it is preferred to construct this apparatus

is represented in the accompanying drawings, in which *b*, fig. 1, is a metallic conical vessel, with a concave plate or disc at bottom. The upper edge of this vessel is bevelled inwards around its circumference to receive the edge of the belts *f* and *g*, the inner edges of which are there secured by a plate *e*, depressed or sunk in the centre, which has a bevelled and grooved flanch, so that when the plate *e*, is drawn towards the bottom plate by four or more screw-bolts *h*, the belts are griped and firmly held between the grooved edge of the vessel and the bevelled or grooved flanch. The outer edges of the belts *f* and *g*, are connected with and held by the cylindrical vessel *a*, which surrounds the vessel *b*, having space enough between the two for the working of the belts, which by the pressure of the contained air are alternately pressed against and sustained by the inner periphery of the conical vessel. The belts are secured in vessel *a*, by making its cylindrical part in two portions. The edges of these two parts, where they come together, are bevelled or grooved to receive the outer edge of the belts, which are there griped and firmly held by drawing the two parts *a* and *a* together by means of screw-bolts *i*, that pass through the head of the vessel *a*, and a flanch in the part *a*.

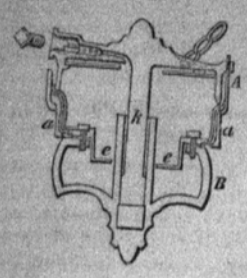


Fig. 1.

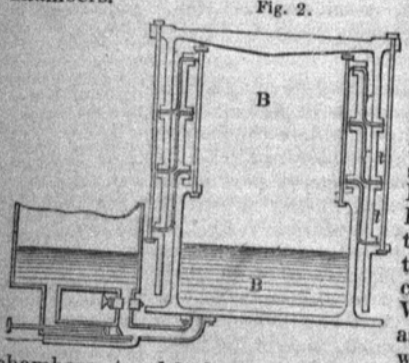
The connecting-belts *f* and *g*, are flexible hoops of india-rubber or other flexible substance impermeable to air, and the edges being firmly held, the space *j* between the two is filled with alcohol or other liquid, which not only prevents all possibility of air passing through, but brings an equal pressure on all parts to prevent rupture.

The connexion of the two vessels *a* and *b*, by means of the belt, divides the apparatus into two parts or chambers *a'* and *b'*, the plate or diaphragm *e* being the division, the inner and depressed circumference of which is perforated with holes to break the passage of the air, as the chamber *a'* is enlarged or contracted by the movement of the two vessels on each other; this perforated plate is, therefore, termed a respirator, as it permits the passage of the air from one chamber to the other, and at the same time checks its too sudden passage, and therefore avoids to a certain extent all sudden jars in cars or other bodies having such springs interposed.

The motion of the two vessels on each other is guided by a rod *k*, attached to the head of the vessel *a*, which passes into a tube *l*, which tube arises from the bottom and centre of the vessel *b*, extending through the centre of the respirator or plate *e*; or guide-rods may be applied outside. The vessel *b*, instead of being conical, may be cylindrical, but the two vessels should be so formed as to present alternately a supporting surface to the belt, which in consequence of the pressure of the air in the chamber *a'*, rolls gradually from one surface to the other, and is therefore at all times supported by either one or the other, or both of these surfaces.

Instead of one respirator or perforated diaphragm two or more may be employed, the more effectually to ease off the passage of the air as it is compressed or expanded, and this respirator may be of any desired form, and may be located in any part of the two chambers.

Fig. 2.



Instead of the double belt above described connected together at the edges, it is contemplated to place two or more single belts separated from each other, as represented at fig. 2, with the liquid in the space *t*; the holes *t*, being made through the outer casing for the introduction of the liquid and closed by a screw-plug. When this apparatus is used as a hydrostatic press, the water is forced into the chambers *a'* and *b'*, by any of the known means which forces apart the two vessels *a* and *b*, in the same manner as in the cylinder and piston press, except that the friction of the moving part is avoided. Air is to be forced into the chambers when the apparatus is used as a spring.

MANUFACTURE OF IRON.

REGINALD JAMES BLEWITT, of Llantarnam Abbey, Newport, Esq., M.P., for "*Improvements in the manufacture of malleable iron.*"—Granted May 27; Enrolled November 27, 1847.

The usual mode of preparing pig or cast-iron for malleable iron is by melting such iron, or by mixing together and melting different qualities of pig or cast-iron with coke, in furnaces called refineries, and keeping it there in a state of fusion, at a great heat, with a strong blast; and the produce, run into moulds, is called refined iron, or metal plate. The patentee uses this, either alone, or mixed with different qualities of pig or cast-iron, in the puddling-furnace, and subjects it to the after process of puddling, by which it is brought into the first state of malleability. He states, he has discovered that a better quality of refined iron, or metal, may be obtained from an air furnace—such as is commonly used for casting, or foundry purposes—than from the refinery, by which there is less waste of metal, and less expense of fuel, in the manufacture. He lights and heats an air-furnace in the usual manner. For each charge about four tons of pig or cast-iron is put in of such qualities as the manufacturer may think most desirable to produce the required quality of malleable iron, as has hitherto been the practice in using refinery furnaces; and the charge, when fully melted and mingled together at the bottom of the furnace, is run into sand, or iron moulds, of any convenient size, and then subjected to the after process of puddling, which is conducted as if using refined metal produced from ordinary refinery furnaces. The fuel employed for heating the air-furnace is a white-ash, semi-bituminous coal of excellent quality, to which may be added, with good effect, 1 or 2 cwt. of charcoal to each charge.

RAILWAY CARRIAGE AXLES.

SAMUEL BENJAMIN EDWARD BERGER, of Abchurch-lane, London, merchant, for "*Improvements in the construction of railway carriages.*" (A communication.)—Granted June 3; Enrolled Dec. 3, 1847. [Reported in *Newton's London Journal.*]

This invention relates to a mode of connecting the axle-boxes of railway axles with the framing of the carriage, whereby the axles will have a slight horizontal play, sufficient for them (when travelling over curves) to take a line parallel to the radius of the curve over which they may be passing. This is effected by connecting the axles to the carriages in the manner shown in the annexed engravings. For four-wheel carriages the apparatus is

Fig. 3. Fig. 2.

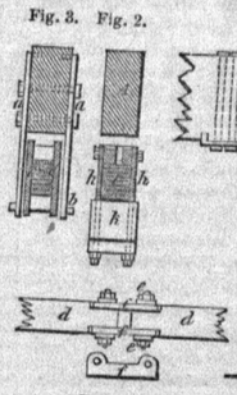


Fig. 1.

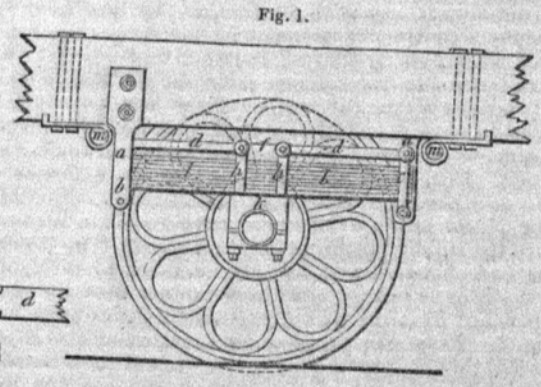


Fig. 4.

shown in figs. 1, 2, 3, and 4. A, A, is one of the two main side-beams of the framing of the carriage; and as side case of the carriage is similarly furnished for the support of the axles, a description of the parts pertaining to one end only of an axle will suffice to explain the nature of the invention.

a, *a*, are four arms or brackets, bolted, two on each side, to the beam A; and at their lower ends they are coupled together, in pairs, by a bolt or pin *b*. These pins each carry two links, *c*, *c*; and through their ends a coupling-pin is passed, and secured in its place by rivet-heads or otherwise. *d*, *d*, are two rods or bars, provided at each end with eyes, for the purpose of being connected respectively at their outer ends by the coupling-pins of the links *c*, *c*, and at their inner ends, of being jointed together by the coupling-pins *e*, *e*, and intervening links *f*, *f*. These coupling-pins *e*,

which are secured in their places by screw-nuts, also pass through the eyes of pendant-links *h*, *h*, which pass through the step or axle-box *k*, and hold it in suspension. *l* is the bearing-spring, composed of layers of steel plates, piled one above the other, and embraced by the links *h*, *h*, which, when screwed tight to the axle-box by the nuts (shown in the drawing), cause the horizontal links *f* to bind tightly upon the middle of the steel plates, and hold them securely together. It will now be understood, that when it is desirable for the axle to take a position other than a right angle with the side of its carriage, such movement will be permitted by the links *c*, *c*, being free to oscillate. In order, however, to check an undue horizontal movement of the axle, and allow of its adjustment only to a line parallel with the radius of the curve over which the carriage is passing, elastic stop or check-pieces *m*, *m*, are provided, as shown at fig. 1; and placed in such a manner, as to allow of a free motion of about a $\frac{1}{4}$ to $\frac{1}{2}$ inch; so that, whenever the axle may have a tendency to sway too much, either forward or backward, the links *c*, *c*, will come in contact with the pieces *m*, and be prevented from moving further. This horizontal movement of the axle will only occur when the railway deviates from a straight line; but when the carriage again pursues a straight course, the axle will regain its position at right angles to the length of the carriage.

Another modification of the invention, applicable to a six-wheel carriage, is also described in the specification, fig. 5 being a side

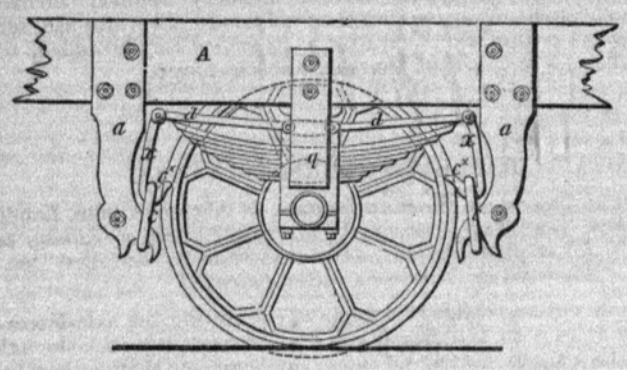


Fig 5.

elevation; to allow the axles to move laterally, as well as in a forward and backward direction, in order that, in a carriage having three or four pairs of wheels, the hind wheels may follow the front pair, not always in a straight line, as they are now obliged to do (whereby a continuous abrasion of the flanges against the rails is caused when passing curves), but that they may take a position on the rail suitable for compensating for the difference in radius of the two sides of the curve of a railway, and permit the cone peripheries to work efficiently for that purpose. In this modification, the same or analogous parts are marked with similar letters of reference. Instead of the four arms *a*, fig. 1, forked arms *a*, are made to embrace the beam A; and at the junction of the prong, filling-pieces are provided, and cross-rods are also employed, to insure the rigidity required for the arms *a*. The lower ends of the arms *a* are hook-shaped, and are intended to receive respectively the shackles or links *c*, *c*, which, together with the coupling-hooks *c**, pendant from the bars *d*, perform the same office as the links *c*, in fig. 1. From the peculiar construction of this coupling, it will be seen that a lateral play or movement is allowed to the axle, entirely independent of the carriage-framing (no fixed point of vibration being employed, as at fig. 1); and, consequently, the object desired, viz., giving a lateral as well as a backward and forward motion to the axle, will be obtained. In order to limit the horizontal motion of the axle, the space for oscillation is contracted at *x*, *x*, (fig. 5). To guard against the danger which would result from the breakage of either of the shackles *c*, a block of wood is attached beneath the framing, which, in falling, will be caught by a block resting on the coupling-links of the bars *d*. *q* is a shield for preventing the step or axle-box *k*, from getting displaced, in the event of such an accident as above alluded to.

The patentee claims the modes, herein described, of connecting the steps or axle-boxes to the framing of railway carriages, whereby the axles of such carriages are enabled to shift their positions, with respect to the frames of the carriages, for the purposes above set forth.

MANUFACTURE OF IRON.

William Vickers, of Sheffield, for, "*Improvements in the manufacture of iron.*"—Granted June 19; Enrolled December 19, 1847.

The improvements consist in melting pig-iron with wrought-iron, and running the melted mixture (when divided into streams) into water; and then converting the product into malleable, or wrought iron, in the following manner:—Pig-iron is to be melted with scrap of wrought-iron or turnings, in any suitable furnace, (a cupola furnace is recommended); and the proportions of wrought-iron with pig-iron may vary greatly, but that a very small addition of wrought-iron to pig-iron, run into water, will be found to produce a great improvement in the quality of iron manufactured therefrom. Sometimes the following proportions are employed:—To 30 parts of wrought-iron are added 70 parts of pig-iron, by weight; and, although this may not be found to answer for some purposes, it has been found to answer well. If, however, the iron should be intended to be made into steel, it will be necessary to increase the proportion of wrought-iron, by mixing with the pig-iron about 40 per cent. of wrought-iron. In the manufacture of iron intended for general purposes, there may be used, with advantage, a mixture of 30 per cent. of scrap of wrought-iron, or turnings, with pig-iron; and such mixture, when melted, may be divided into small streams, and run into water, in any convenient manner. For this purpose, the patentee states he has used the following arrangement:—He takes a cast-iron tray, perforated with holes of half-an-inch in diameter, and this is lined about half-an-inch thick, with sand or composition, such as is used for stopping cupola furnaces with; which is punctured with holes about a quarter of an inch in diameter—such punctures being immediately over the holes in the tray, and then the tray is placed about 15 feet above the level of the water in the tank (employed for solidifying the iron), which is of wood, and about 4 feet deep; and the melted metal passing from the furnace, through the perforated tray, into the water in the said tank, will be found therein in a divided state. This product is used in the manufacture of wrought-iron, and is treated the same as in the manufacture of wrought-iron from pig, or refined iron. The patentee adds, that he has used, with advantage, in the melting of pig-iron with wrought-iron, from 3 to 5 per cent. of black oxide of manganese, which he believes will be found to be advantageous. This may be added from time to time, by placing small pieces in the tuyere holes—the blast dividing it in the furnace as the mixture becomes melted. The patentee does not claim the melting of wrought-iron with pig, or cast-iron, nor the running of melted cast-iron into water, when separately considered; neither does he claim the precise mode set forth, so long as the peculiar character of his invention be retained; but what he claims, is melting pig-iron with wrought-iron scrap, or turnings, and then running it into water, and using the product in the manufacture of wrought, or malleable iron.

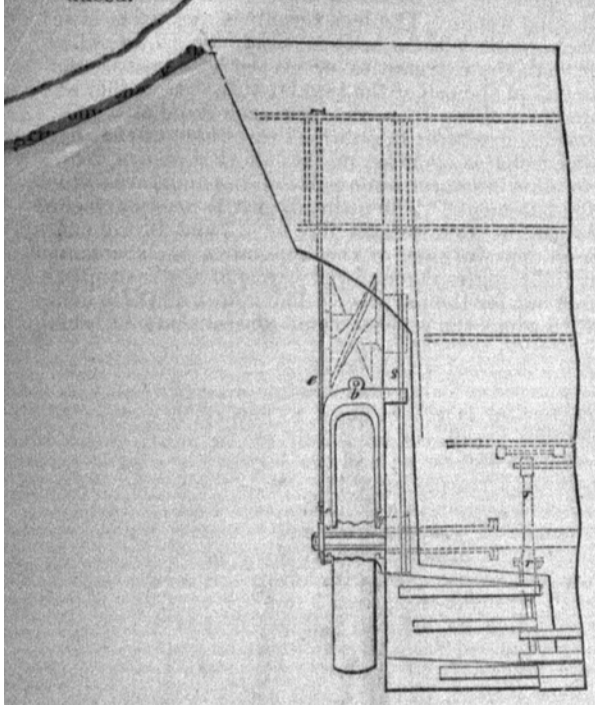
STEERING VESSELS.

William Henwood, of Portsea, naval architect, for "*Improvements in propelling vessels, and in steering vessels.*"—Granted May 4; Enrolled November 4, 1847.

The first improvement in propelling and steering relates to screw-propelled ships or vessels, and consists in placing the screw-propeller at the aft-side of the sternpost, where the rudder is in vessels generally, and in applying the rudder on the fore-side of the screw-propeller, in the lower and aftermost part of the run, and below the propeller-shaft, the rudder being substituted for the same part of the run of the vessel, as shown in fig 1. The lower end of the sternpost meets the keelson, or timber running under the shaft, at about the height of the centre of the shaft; and the one may be united very securely to the other, by a flanch or flanches on the shaft cylinder, let into and bolted to the sternpost and keelson. This keelson, or timber, should be large in siding, because of the hole through it for the rudder-head to pass through; and it must have a rabbet to receive the bottom plank.

The propeller is connected with the sternpost and vessel very firmly by a metal coupling-box *a*, which has a metal-frame *b*, attached to it for raising and lowering the propeller; the coupling-box and hoisting-frame being formed with tongues, to slide in metal-faced grooves in the sides of the sternpost *s*, and the coupling-box having an interior collar, of the utmost requisite strength, fitted against a corresponding exterior collar round the propeller. The union of the propeller to the ship is thus made abundantly strong for pressing the shaft into the propeller, and "backing

astern." An after-bearing for the shaft may be formed by the metal-rod *e*, set up with a screw to the stern; which rod would also form an additional stop for the propeller on the shaft in backing astern. Or a rod might be attached to the upper and after-part of the hoisting-frame, and set up with a screw to the vessel's stern; and a small rod may be applied at the aft-side of the hoisting-frame, for inserting a forelock in the end of the shaft, to secure the propeller in backing astern, which forelock would revolve with the shaft on the pin at *x*. The surface of the rudder may be as large as that of the immersed part of the common rudder, although as the pressure of the water on such a rudder would be once and a half as great as on the common rudder, a much smaller surface would be sufficient for steering, and the lower part might be reduced.



A large and very strongly formed rudder-band is fitted at the upper part of the rudder, with a large hole through it, of a square, hexagonal, or other form, into which the rudder-head *r* is fitted for turning the rudder; the lower rudder-bands might also be formed similarly, and the braces fitted with an internal ring, that the rudder-head being extended downward as a substitute for the rudder-pins, may revolve in the braces, whilst it is fixed in the rudder-bands for turning the rudder. The rudder-head above the upper rudder-band is cylindrical, and passes through a metal cylinder with a stuffing-box. It then surrounds the propeller-shaft so that the rudder may turn sufficiently in steering; and it extends to any convenient height to receive the tiller. Should the rudder be carried away a temporary rudder could be applied, by taking up the propeller, using sails only, and having the temporary rudder prepared with braces to slide down the sternpost grooves; by which it would be held securely to the ship, its lower end being secured with guys.

The advantages to be obtained from this improvement are, the maximum effect of the screw-propeller in propelling; the avoidance of risk of serious damage from a vessel's grounding, and the preservation of the strength, and the form, and the displacement of the after-part of a vessel.

The claim is for the right of applying a screw-propeller and a rudder conjointly to a ship or vessel in the positions above-mentioned, and as shown in the engraving. The improvement in steering vessels consists also in applying a similar rudder to a ship or vessel not propelled by a screw.

Such a rudder could be either shipped or unshipped afloat, by attaching a water-tight hose or cylinder to the rudder-head cylinder, so that the rudder-head *r*, with the rudder-pin or pins attached to it, may be drawn up in unshipping the rudder, or replaced in shipping it. The keel may extend under the rudder, as shown in the engraving, to protect it in grounding.

The advantages of such a rudder are, much less first cost, indefinite durability, through being always under water, being below the impulses of waves, so that the steering would be uniformly steady, and without hazard to the helmsman, both when a ship is laden, and when she is light; and it is quite below the reach of shot.

Another improvement in propelling vessels consists in making that part of the immersed volume, which is abaft the vertical and transverse plane in which the centre of gravity of the vessel is, of such a form, that the longitudinal stability of the after-end of the vessel may be practically equal to that of the fore-end:—in order that the pitching motion, so far as it may be caused by the form of the immersed volume, may be prevented; and that there may be the least possible resistance of the water to the propelling power. This is of especial importance in screw-propelled vessels, because pitching raises the screw above the water's surface.

The equal stability of the fore and the after-ends of a ship, is obtained by making the area of the load-water section abaft the above-mentioned vertical and transverse plane, equal to the area of the remaining part of the same water section, on the fore-side of the same plane; and the moments of those areas, from the same vertical and transverse plane also equal; and by forming the lower horizontal sections or water-lines in a similar manner; or so that the cubic contents of the immersed volumes, on each side of the same vertical and transverse plane, and the moments of the same immersed volumes from the same plane, shall likewise be equal, the one respectively to the other. A vessel of remarkably beautiful form may thus be produced. As the propelling power of the wind on the sails always depresses the fore-end of a ship, when it impels her onward, just as it depresses the lee-side, when the wind acts obliquely, it appears contrary to the dictates of reason and of science, that ships should have, as they commonly have, less stability at the fore-end than at the after-end. By making the stability equal at both ends of a ship the pitching would be reduced to the least possible degree, the propelling power would produce greater speed, the decks or gun-platforms would be kept more nearly in their horizontal positions, and the dangers and discomfort and expense of "wear and tear," in rough weather, would be materially diminished.

The claim is for making ships or vessels of the form above described, so that the longitudinal stability of the fore-end may be practically equal to that of the after-end.

LOCOMOTIVE ENGINES.

THOMAS RUSSELL CRAMPTON, of Adam-street, Adelphi, engineer, for "*Improvements in locomotive engines.*"—Granted June 19; Enrolled Dec. 19, 1847.

The improvements relate to the construction of the locomotive engine.

The first improvement consists in introducing two pairs of driving-wheels, one pair to be placed behind the fire-box, and the other pair forward, in such manner that the weight of the boiler and machinery may be borne equally by each pair of driving-wheels. By this arrangement, the adhesion of the wheels upon the rails will be more uniform. The two pairs of driving-wheels are to be connected on the side by rods in the usual manner, or connected separately to the driving cylinders, or in any other convenient manner. The mode preferred by the patentee is shown in the seventh improvement. If it be desirable to construct the engine with six or more wheels, the patentee proposes to place them between the two pairs of driving-wheels, but recommends that they should bear but little of the weight, by the employment of light elastic springs.

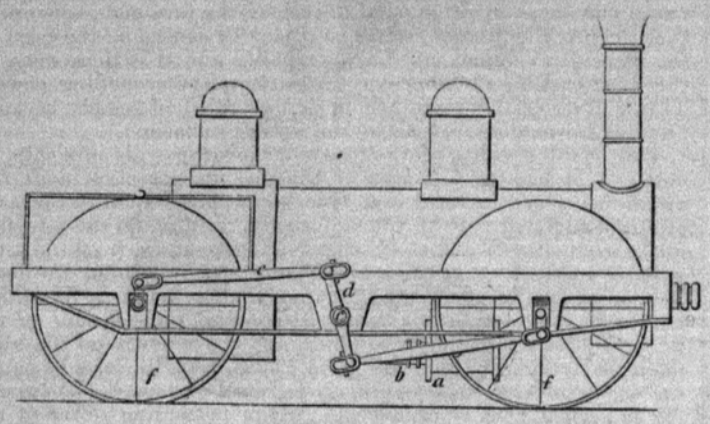
The second improvement is in the construction of the fire-boxes, for the reception of the axles of the driving-wheels, the driving-wheels of the locomotive engine being placed more forward than the back of the fire-box. If large wheels are to be used, a recess is to be formed transversely in the upper part of the fire-box for the axle; and for smaller wheels, a recess is to be formed in the lower part of the fire-box: this latter arrangement divides the fire-bars into two parts. By either arrangement, the heating surface of the interior fire-box is increased, and the evaporative power of the boiler augmented.

The third and fourth improvements consist in such arrangement of the various parts of the locomotive, that the axle of the fore or leading wheels may have outside bearings, and the axle of the drawing or after-wheels behind the fire-box, inside bearings.

The fifth improvement consists in placing the eccentrics for working the valves on the outside of the driving-wheels, by elongating the axle some distance through the boss of the driving-wheels; the crank-pin, instead of being fixed to the boss of the driving-wheel, is fixed to a separate crank fastened to the end of the elongated part of the axle, leaving sufficient space between

the crank and the boss of the wheel for the reception of the eccentrics upon the axle.

The sixth improvement is for transmitting the power from the steam cylinders to the driving-wheels, by introducing a vibratory shaft in the centre between the driving-wheels, as shown in the annexed figure. The steam cylinders *a* are fixed to the under-



side of the boiler, with short connecting-rods *b*, which act on cranks or levers keyed on to the central shaft *c*; and on the ends of the latter are two arms or levers *d d*, which, through the two connecting-rods *e e*, cause the two driving-wheels *f f* to revolve.

LIGHTING BY ELECTRICITY.

William Edwards Staite, of Lombard-street, gentleman, for "*certain Improvements in lighting, and in the apparatus or apparatuses connected therewith.*"—Granted July 3, 1847; Enrolled January 3, 1848. [Reported in the *Mechanics' Magazine.*]

This invention relates to a method of lighting by electricity, as shown in the annexed engravings. Fig. 1, an external elevation of the apparatus; fig. 2, a sectional elevation on the line W*x* (fig. 3); and fig. 3, a horizontal plan on the line *y z* (fig. 1). The patentee describes his apparatus as follows:—

M, and N, are two cylinders of carbon, prepared as is afterwards described, which are used as the electrodes, that is to say, the current of electricity is passed from one to the other as they stand end to end, their ends being separated by an interval of from less than one-twentieth to about half an inch, according to the power of the electric current used. The upper electrode, N, is passed vertically through a hole in the summit of the metallic support, or tripod, K, and fixed by binding screws. The lower ends of the legs of the tripod are passed through holes in the circular main-plate, A, of the apparatus, and secured in their positions by collars and nuts, but are carefully prevented from coming into metallic contact with the plate A, by means of washers *a a*, of some dry, hard, non-conducting wood. The legs terminate at bottom in set screws L L, which connect them with a conducting wire, which passes round through the extremities of all the legs, and is connected with one end of the coil of the regulator R. The other end of this coil is led to a clamp B^2, with a set screw fixed at one side of the square wooden basement B, on which the whole of the apparatus is built, and which is mounted on four short supports, *b b b b*, at its corners, to allow room for some parts of the apparatus which project below the basement. The main-plate A is firmly attached to the basement B, by four pillars, *c c c c*. C, and D, are cones which spring from opposite sides of the apparatus, their common axis passing at right angles through the centre of the main-plate, A, which is bored out for the purpose. The apices of these cones are perforated, to admit the perpendicular central shaft, O, which

Fig. 1.

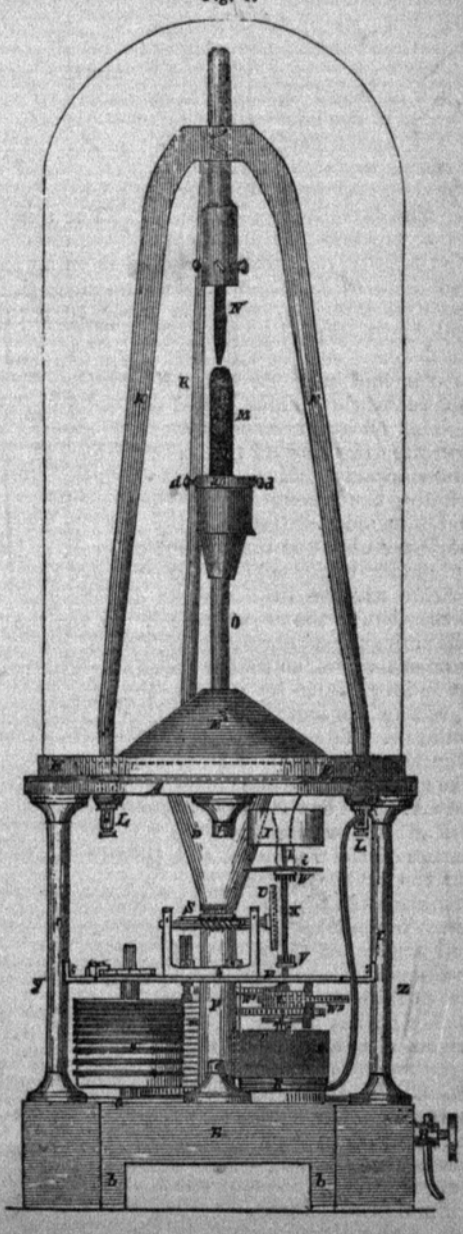
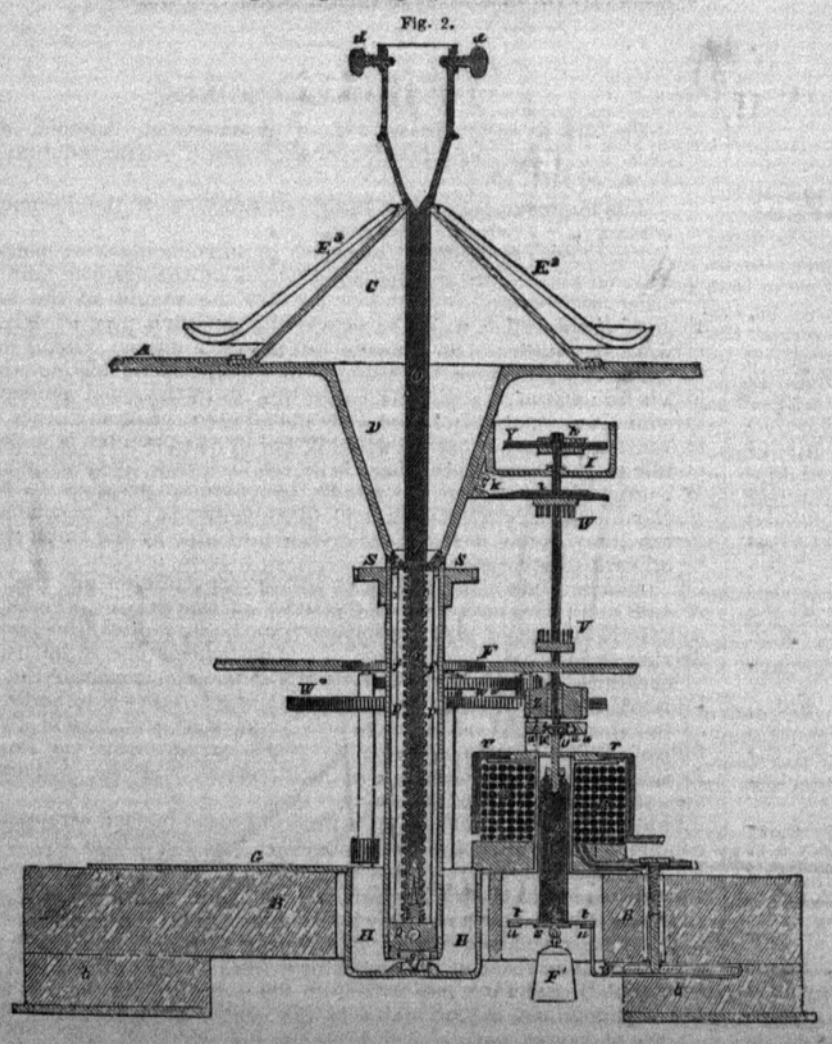


Fig. 2.



has a socket for receiving and holding the lower electrode M, at its upper end; and this socket is furnished with set screws for securing the electrode in an upright position in its centre, even though that electrode should happen to be of smaller size than the socket. At the bottom the socket is made of a conical form, in order to keep the lower end of the electrode steady and concentric, so that it may be properly adjusted by the set screws, *d d*. This shaft O has a smooth straight part, below its socket, for a length equal to the distance between the apices of the fixed cones, C and D, which is equal to the amount of rise which the shaft admits of, to compensate for the wear or shortening of one of the electrodes, while the light is in action; this smooth part of the shaft moving freely through the hole in the apex of the upper cone. Below this smooth part the shaft is continued for an equal length, screwed; the threads of the screw giving about one-twelfth of an inch of rise for every turn. This screwed part works through a nut *e*, which is set tight in the apex of the under cone D, and passes down the centre of a hollow cylinder or tube P, which is slotted internally (as shown at *f f* in figs. 2 and 3). A little cross piece of metal, Q, is set tight on the bottom of the shaft O, by being screwed fast into its end, and this cross-piece Q (which is afterwards more particularly described) fits across the tube P, taking into the slots or grooves on each side, so that it can slide up or down in them. When, therefore, the tube P is made to revolve, it carries the shaft O round with it, by means of the sliding cross-piece Q, and makes it to rise or sink by its screw working in the fixed nut *e*, so that the shaft O, carrying the electrode M in its socket, has a rotary motion combined with its vertical motion, for the purpose of equalizing the wear of the electrodes on all sides. The tube P turns on a pivot *g*, which works in the bottom of a circular box of metal H, which is screwed into a hole of sufficient size in the bottom of the brass-plate G, which is fixed to the upper surface of the wooden basement B. The touching surfaces at the pivot *g* are coated with silver, as that metal presents a surface peculiarly fitted for receiving the current of electricity. The upper end of the tube P receives the outer part of the fixed nut *e*, on which the tube turns, and is steadied as on an axis. On the upper part of the tube P, a worm-wheel S, carrying forty teeth, is attached, which is made to revolve by a horizontal double-thread tangent-screw T, the pitch radius of which is one-tenth of an inch. To one end of the screw is attached a crown-wheel U, carrying forty teeth, which is actuated by pinions V and W, on an upright spindle X. The pinions are at a somewhat greater distance apart than the diameter of the crown-wheel U, and gear into it from opposite sides, so that when the spindle X is raised a little, the lower pinion V (having eight teeth), is geared into the lower side of the crown-wheel; but when the spindle is sunk, the lower pinion is thrown out of gear, and the upper pinion W gears into the upper side of the crown-wheel; and the spindle continuing to revolve in the same direction as before, imparts a reversed rotation to the crown-wheel. When the spindle is kept at a medium degree of elevation, neither of the pinions is in gear with the crown-wheel, so that it remains quiescent. This spindle X is kept in its position by working through a hole in the middle plate, F, of the apparatus, which plate is attached firmly to three of the pillars *c*. The upper end of the spindle works through a hole in the centre of the bottom of a circular brass box I, which is fixed to the side of the under cone D, or to the under side of the main-plate A. The box I contains a centrifugal regulator Y, which consists of a bit of watch-spring bent into the form of the letter S, carrying two little weights *h h* at its ends, and fixed horizontally across the top of the spindle by the middle part of the spring, which fits into a cleft in the top of the spindle, and is secured by a small nut. When the spindle is made to revolve too fast, the weights at the end of the spring fly outwards by their centrifugal force, and begin to touch and rub against the sides of the circular box I, which friction checks the motion. This description of governor preserves the motion more uniformly than the ordinary sort of fly, which acts by the resistance of the air. Just below this centrifugal governor there is a cross-piece *i*, inserted through a transverse hole in the spindle X, so that when the spindle is at its medium degree of elevation, that is to say, when its two pinions V and W are neither of them in gear with the crown-wheel, the ends of the cross-piece *i* meet a stop *k*, which may project from any fixed part of the apparatus, such as the cone D, and so stop the revolutions of the spindle; while, as soon as the spindle is raised or lowered, the cross-piece *i* no longer meets the stop *k*, but passes over or under it, amd allows the spindle to commence its revolutions just before one of the pinions gears into the crown-wheel. The spindle X is actuated and kept with a constant tendency to revolve in one direction by a toothed wheel Z, keyed on to it just below the middle plate F, and this wheel is driven by a train of wheelwork W^1, supported between the middle and bottom plates F and G, similar to ordinary clockwork, and which is driven by a spring in a barrel *l*, acting on a fusee *m*, driven by a cord or chain; or the wheelwork may have any other contrivance as its prime mover, as, for instance, a common barrel with a cord and weight. The wheel *Z* is of such thickness that the motion up and down, which the spindle X admits of, will not ungear it from the next wheel in the driving train.

Fig. 3.

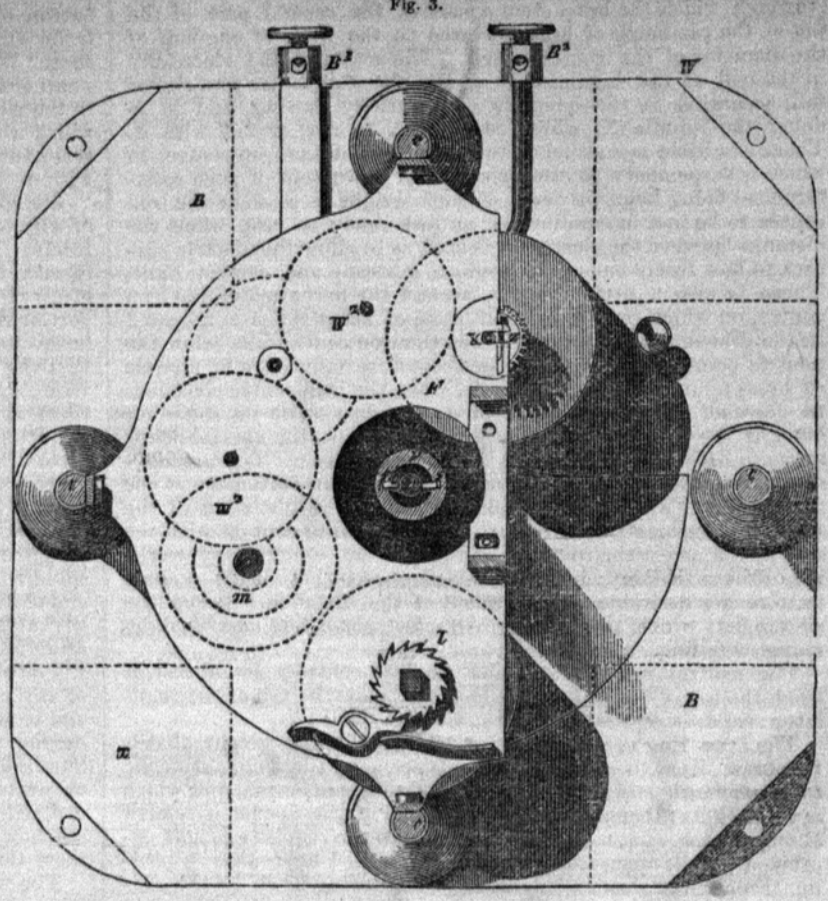
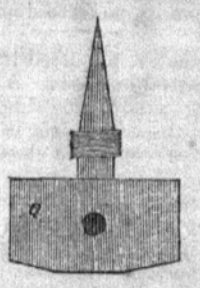


Fig. 4.



The mode in which the spindle X and its pinions are raised or lowered, so as to vary the motion of the crown-wheel U, and thereby of the electrode M, according to the exigencies of the light, is as follows:—The bottom of the spindle X terminates just below the driving-wheel Z, and rests on a plate of ivory *n*, which is supported on a short upright stem of brass *o*, which has its lower end screwed into a hole in the top of a solid cylinder of soft iron, *p*. This iron can move freely up and down in the central hole of a reel *q*, round which a quantity of insulated copper wire is wound: one end of this wire is led to the binding screw B, as before mentioned, which connects it with the positive wire of the galvanic regenerators, and the other end to the wire which passes through the binding screws L. The reel *q* of the regulator is fixed firmly to the wooden basement B, and a cap *r* of soft iron fits over it; but the iron of the cap does not extend quite to the centre of the hole in it

(through which the brass stem *o* passes), the central part of the top of the cap being of brass soldered to the iron, of one-half of the diameter of the iron cap itself. The action of the electricity in the coil of the regulator R causes the iron centre *p* to rise or fall, according to the quantity of electricity passing, and in so doing, the spindle X, which rests on it, to rise or fall with it. There is a little eye attached to the bottom of the iron centre, to which is suspended a counterpoise F′ (an assortment of such counterpoises being kept for use), of such weight as to allow the iron centre to be just in equilibrium, or just ready to rise, when the distance between the electrodes is such as to allow the electric current to flow freely enough to produce a steady and certain light. There is also a little ledge *s*, around the lower end of the iron centre, on which rests a disc *t*, of brass, of about the size indicated in the drawing, fig. 2; which (when the iron centre falls below the neutral point) becomes supported around its outer edge by a circle of brass *u*, and is left behind on it, when the iron centre continues to descend, thus relieving it of its weight; while on the other hand, if the iron centre is disposed to rise above the neutral point, it has to lift the whole weight of the brass disc *t*. This arrangement gives the iron centre a tendency to remain stationary at the neutral point, which is that point at which the elevation of the spindle X enables the cross-arm *i* to come into contact with the stop *k*, and arrest the rotation, and so prevent unnecessary working of the machinery, until the electric current has varied so much as to render desirable an adjustment of the distance between the electrodes; which the iron centre effects, as before described, by rising or falling.

The neutral position at which the iron centre *p* should rest, is when the top of the iron centre is as far below the top of the regulator reel as is represented in fig. 2.

The brass ring *u*, which supports the equilibrium weight, that is the brass disc *t*, is secured at the proper height by being attached to a sufficiently stiff strip of brass *w*, of a certain length, and which is fixed by its other end to the other side of the wooden basement B. The brass ring *u* can be adjusted to the requisite height exactly, after the apparatus is made, by a milled-headed screw passing through the wooden basement, and screwing down on the supporting brass strip (not far from *u*), so as to depress it to the right position.

The sliding cross-piece Q, before adverted to, is constructed in the manner separately represented in fig. 4. A spring Q (of thin hard brass, for instance,) is attached to one side of the cross part by a small screw, so that when the cross-piece is placed in the slots of the tube P, the spring always remains in close though not forcible contact against the sides of the slots, so as to insure a good conduction to the electric current which has to traverse the shaft, and enter from the cross-piece into the slotted tube.

The tangent-screw T is made not quite horizontal, but inclined at an angle of one in twenty, because the lower pinion V is smaller than the upper one; and therefore it is necessary that the lower edge of the crown-wheel U should be tilted nearer to the axis of the spindle X. The lower pinion is made smaller, in order that it may the better wind down the main shaft O, after it has screwed itself up, until the ends of the electrodes come into firm contact, lest it should stick in that position.

The screw No. 1, which fastens the stand 3 of the tangent-screw to the middle plate F, passes through a hole 4, enlarged sideways in the stand; so that by only loosening the screw 1, the stand may turn on the other screw 2, as a centre, so as to allow of the tangent-screw T being adjusted to the right distance from the centre of the wheel S, in order that it may work properly into its teeth, or, when required, to throw the tangent-screw out of gear with it altogether.

The thread of the screw of the main shaft O, should be of a square form, so that it shall work with as little friction as may be, when supporting the weight of the shaft and electrode.

A cone of white glass or porcelain, E′, is made to slip over the upper cone C of the main plate, and is turned up at the edges (as shown in figs. 1 and 2), to reflect the light better, and to catch any dust and ash which may be thrown off from the electrodes.

A glass shade, which may be ground partially or not, as desired, fits over the electrodes, M and N, and the stand K, and is screwed down to the main-plate A, by the brass circle E, into which its lower edge is cemented, whereby the electrodes are enclosed entirely from the outer air. As soon as they have exhausted the oxygen which is within the glass shade, they are no longer so rapidly consumed. When the electrodes, however, are composed of some inferior sorts of carbonaceous preparations they give light more steadily if a very small quantity of atmospheric air is continually allowed to enter; that is to say, just sufficient to burn away the button of carbon which sometimes forms on the end of that electrode which is not undergoing decomposition by the electric current. When there are no holes in the glass shade to admit of a small quantity of atmospheric air, two light valves may be inserted in the main plate A, one opening inwards and the other outwards, which would provide for the varying pressure of the air when the temperature is altered by the presence or absence of the light within.

The coil of insulated wire of the regulator R, should be composed of wire of such thickness as to conduct the electric current quite freely. For an apparatus of the size represented in the engravings it may be about three-sixteenths of an inch in diameter; but if electrodes of a larger size are employed, the wire should be proportionally increased in thickness, and the regulator R, made as large as the dimensions of the apparatus will admit of, in order that the reel should take a sufficient number of turns of the thick wire; for with wires too thin, considerable heat is evolved from them when transmitting the current. Two circular brass weights, *aa*, fit one over the other around the ivory top *nn*, which carries the pivot of the spindle X; their use is to enable an easier and more precise adjustment of the weight on the iron centre than can be effected by altering the large weight F′, which is hung at the bottom of the iron centre.

When it is intended to use small currents of electricity, the spindle X, and all its appurtenances, should be made very light, and the iron centre may for the same object be made hollow with advantage; its sides, however, should not be less than one-twelfth of an inch in thickness.

The electric current may be obtained from a galvanic apparatus of any of the known sorts, or from any other convenient source; and it may be used of various intensities and quantities. A good degree of intensity to use, is such as would be afforded by one hundred cells in a series of the usual sort employed in galvanic apparatuses; and the quantity of the current may vary from that evolved by the consumption of less than one-and-a-half grains of zinc per minute in each cell, to that evolved by the consumption of more than fifteen grains of zinc per minute.

The wire from the positive, that is, the zinc pole of the galvanic apparatus, is clamped with the binding screw at B^2, which serves as the conductor through the regulator coil, and then up to the upper electrode N. The wire from the other, or negative pole of the galvanic apparatus, is to be clamped with the other binding screw at B^3, which is connected by a slip of metal (copper) to the bottom plate G of the apparatus, so that the current passing from the lower end of the upper electrode N to the top of the lower electrode M, then traverses the central shaft O, passes through the cross piece Q, at its lower end, into the slotted tube P, and thence through its pivot at bottom into the metallic box or cavity H, which being in metallic connection with the bottom plate G, leads the current to that plate and thence by the slip of copper to the other clamp, from which it passes in return circuit through the negative wire of the galvanic apparatus. The current, when first applied with the electrodes in contact, flows freely, and that causes the regulator (being properly weighted) to raise the spindle X, and thus put the apparatus into gear for screwing the centre shaft O downwards, and gradually separating the electrodes, whereupon the light begins to appear between them.

The patentee then describes the method of preparing the carbon for his electrodes:—About equal quantities are taken of coal of a medium quality, and of the prepared coke, known as "Church's Patent Coke," and both reduced to a state of fine powder and intimately mixed together. The mixture is then placed in close wrought-iron moulds, which may be made either to give the mixture the form of a block, to be afterwards cut into pieces of the required shape, or to give at once to the mixture the form of the intended electrode. In all cases it preferred to make the moulded mass of not more than 3 or 4 inches in its least diameter, for when larger it is liable to have fissures, and not to be of such uniform density. The mixture being placed in these moulds, is subjected to heat and heavy pressure until it becomes consolidated into a very dense and firm mass. And when the mass is in a heated state it is plunged into sugar, melted by heat (without the aid of any liquid,) and kept therein for a short period. It is then taken out and allowed to become cold, when it is placed amongst pieces of charcoal in a close vessel, which is gradually heated until it attains a full red heat, after which the temperature is increased to an intense white heat; at which it should be kept for many hours, or even two or three days, according to the hardness and compactness desired. Or the mass may be a second time immersed in the melted sugar while hot, and the remainder of the process be again repeated as before.

By coating the mass in this way with melted sugar, any pores that may be in it (on its external surface at least), are filled up with carbonaceous matter, and any subsequent drying rendered unnecessary.

The following the patentee states to be the best dimensions for the electrodes:—The lower electrode should be as long as can be conveniently manufactured (8 inches for instance,) when used for ordinary purposes, and it should be of a cylindrical form. The smaller the diameter is, the better the light; but the larger the electrode is (in cross section), the longer it will last with a given current of electricity. The upper electrode need not be of any great length; it is well, however, to have it about one-third as long as the lower one, and of half the diameter.

The patentee concludes his specification with the following account of a method of employing currents of electricity to actuate apparatus for effecting the speedy lighting up and extinction or obscuration of signal lamps in which oil, camphine, or other like inflammable fluid is the illuminating substance employed:—Suppose, for example, there are three such lamps with different coloured glasses, say white, green, and red, which are required to be sometimes lighted, and at other times extinguished or obscured, as is usual on railways, and not all at once, but in a particular order of sequence, or each under particular circumstances only, I effect this in the following manner. The three coloured signal lamps are placed side by side, or they may be placed one above the other. A sectional elevation of one of these is given in fig. 5. A′ is a bar of

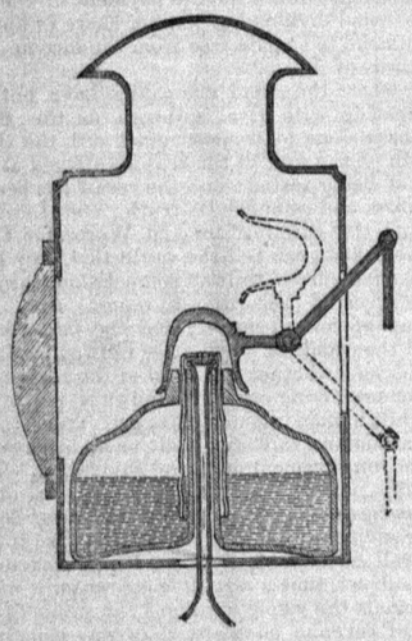


Fig. 5.

metal, having a drop bar B′, attached to it. These bars are for the purpose of working three extinguishers, one to each lamp. The figure shows one of these extinguishers as applied to a lamp; the dotted lines in the figure indicate the position which it assumes when raised up. The drop bar B′ is attached to a clockwork escapement, the detent of which is alternately retained and liberated by the passage of electric current, and by its mechanical force raises up the bar B′, and causes the light, in whichever lamp it may be, to be put out. The three extinguishers are made to move together, to save the necessity of each being provided with a separate extinguishing mechanism. In the centre of the burner of each lamp is a ring *a*, of fine platinum wire, which is so contrived as to touch the wick of the lamp, and the current of electricity being made to pass through this platinum ring, it becomes intensely heated, and thereby ignites the wick of the lamp. I do not restrict myself, however, to the employment of platinum wire, as carbon for this purpose may be used, or any other difficultly-fusible material; neither do I limit myself to the employment of a ring of any particular form. The wick may, for instance, be a flat wick, and in that case a straight piece of wire would be suitable for the arrangement.

ARTIFICIAL FUEL.

BONDY AZULAY, of Rotherhithe, Surrey, printer, and ABRAHAM SOLOMONS, of London, merchant, for "*Improvements in the manufacture of charcoal and other fuel.*"—Granted June 10; Enrolled Dec. 10, 1847.

This invention relates, first, to the manufacture of charcoal, to avoid waste caused by breaking it. This is effected by reducing the waste to powder, and then compressing it, by an hydraulic press or other apparatus, in moulds, until the mass is reduced to from one-fifth to one-eighth of its original bulk.

The second invention relates to making fuel of small coal, breeze, coke, and cinders, with or without charcoal, by pulverizing the whole, and then compressing the powder into blocks.

The third invention relates to making a fuel for lighting fires, by mixing charcoal powder, small coal, breeze, coke, and cinders (all or any of them), with tar, pitch, resin, or other suitable inflammable substance, and compressing the mixture in moulds; and when taken from the mould, the block is dipped in the tar, &c., and covered with saw-dust and wrapped in waste paper: a block so prepared will readily ignite on the application of a lighted match.

WATER GAUGE.

ALFRED VINCENT NEWTON, of 66, Chancery-lane, Middlesex, mechanical draughtsman, for "*Improved apparatus to be applied to steam-boilers.*"—Granted April 15; Enrolled Oct. 15, 1847. (A communication.)

The principle upon which the apparatus is constructed is that of a percussive horizontal action of a flat surface upon a portion of the water to be gauged. One form of apparatus on this principle is shown in the annexed engravings, figs. 1 and 2, being an external view and section. *a*, the steam-boiler; *b*, a small cylinder

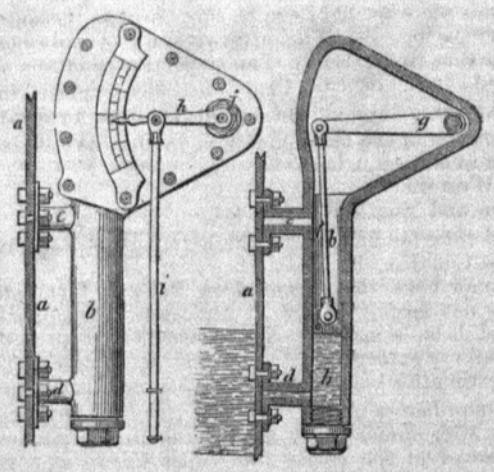


Fig. 1. Fig. 2.

communicating therewith by two tubes *c d*, the upper one with the steam, and the lower with the water; *e*, a piston, moving freely in the cylinder *b*, and connected by a rod *f*, to a vibrating lever *g*, enclosed in a quadrant-shaped chamber. The pivot of the lever *g* passes through a stuffing-box *j*, made at the small end of the quadrant, and carries externally another lever *h*, furnished with an index for indicating, on a graduated scale, the height of water in the boiler. A rod *i* is suspended from the lever *h*, for enabling the attendant to raise the piston in the cylinder, and bring it down with percussive force on to the surface of the water, in order to ascertain its exact height. It will be at once understood that the same pressure of steam and water must exist in the cylinder and its quadrant case as in the boiler, and that the working of the apparatus cannot be affected thereby.

ON THE IMPROVEMENT OF INLAND NAVIGATION.

By Hon. & Rev. A. P. Perceval, B.C.L.,
Chaplain to the Queen.

Chapter I.—*On the Comparative Prospective Value of Railways and Canals.*

In the month of December, 1844, while a party of travellers and traders were waiting at the Crewe Station the arrival of the up-train, and eagerly discussing railway matters, that mania being then at its height, they were startled from their propriety, by hearing an individual in the room address them thus: "Well, gentlemen, I will back the canals against the railways *now;* I intend to invest wholly in them, and I advise you all to do the same." If a pistol had been discharged in the midst of the company, it could hardly have produced a more striking effect. All stared; and most, by movement or ejaculation, gave token of extreme surprise. Some looked with pity upon the speaker, a clergyman, as though the saying, "*Ne sutor ultra crepidam,*" was passing in their minds, and they contemplated one about to ruin himself and his family by meddling in matters out of his sphere. But when he proceeded to propound, for the consideration of the company, his grounds for the opinion which he had expressed, none were found ready to gainsay the reasonableness of them. They were these:

I. That the wear and tear on canals is so inconsiderably less than on railways, that the former, if properly conducted, must be able to undersell the latter.

II. That while lines of railway may be multiplied *ad libitum*, occasioning unlimited competition, and consequently unlimited reduction of profits, such multiplication of lines of water conveyance is almost physically impossible: consequently, that canals must always retain a comparative monopoly.

III. "Remember, gentlemen," he said, "that human talent and ingenuity have been taxed to the utmost to bring all the appliances that science can afford, to promote locomotion on railways; while, as yet, nothing, or next to nothing, of the sort has been attempted on canals."

Three years have elapsed since these opinions were expressed at Crewe: let us see what light can be thrown upon the soundness of them, by comparing, 1st, The present state of railways with its condition at that time; 2ndly, The respective condition and prospects of railways and canals, then and at the present time.

I. To take three old and well-established lines for illustration:

The value of the under-mentioned was, in Dec. '44; is, in Dec. '47

London and Birmingham	...	,,	228	,,	150
Great Western	...	,,	157	,,	90
London and South-Western		,,	77	,,	50

II. Let us take for illustration the Birmingham Railway and the Birmingham Canal:

In December 1844, the Birmingham Railway furnished to the proprietors, not merely in actual dividends, the 10 per cent. (to which it had been sought by Act of Parliament to restrict the profits on railway enterprise), but advantages in new shares, &c.—in general estimation certainly not less than another 10 per cent.

We have now before us the Report of this company for the half-year ending Midsummer 1847; announcing in the plainest terms, that the second of the causes alleged at Crewe as a reason for regarding railways as offering doubtful security for investment, namely, the liability to unlimited competition, has begun to tell with fearful effect against the prosperity of this most prosperous of railway undertakings, which is no longer able to pay even the legal 10 per cent. The Chairman is stated to have said: "He hoped that before Parliament sanctioned any further extension of the principle of competition, or of reduced fares, they would bear in mind the inevitable results which must follow from pursuing such a course. They saw its effect upon their receipts now..... Competition might go on in consequence of rivalry and contention between different companies; but what would be the effect? The proprietors would interfere and force the directors to reduce the establishments of the two companies to the lowest possible point; trains would be taken off, servants would be discharged, the whole machinery of the companies would be deteriorated, and what would become of the public safety? This would be the result of those doctrines of competition which had been taken up by the legislature."—Here, then, we have the confession of the most intelligent of railway chairmen, at the head of the most influential of railway companies, avowing in the face of Europe that railways afford so insecure an investment for capital, that they cannot possibly be relied upon, unless in their behalf the doctrine of Free Trade, to which all mankind, to speak generally, have given in their adhesion, be repudiated; and an artificial protection be afforded to them, which has been denied, not only to the inland navigation, but even to the agriculture of the country!

Meanwhile, how has the Birmingham Canal been faring? In December 1844, in consequence of the railway mania, it had so fallen in public estimation, and apprehensive value, that projects for draining off the water, and converting the channels into railway beds, were seriously discussed.

We have also before us the Report of this Company for the half-year ending Midsummer 1847: from which it appears, that notwithstanding its operations have been impeded by a very questionable (in point of prudence) alliance which it has contracted with the Birmingham Railway, whereby it has placed itself, to a certain extent, under the control of the latter, on condition of receiving from it a guarantee, in perpetuity, of the customary dividend of £4 per share (a guarantee which it is doubtful whether the railway company would be able to make good, should the canal company ever be so reduced as to demand the fulfilment of it), and notwithstanding a "considerable pressure on the mercantile world," to which in common with the railway, it has been subjected, its affairs are in a state of unexampled prosperity. "The account for the last half-year," the Report says, "exhibits a considerable increase of revenue, the amount for the six months ending 30th of June last, including rents, being £86,425 7*s.* 3½*d.* [being an increase of £21,192 above the corresponding half-year in 1846]. The balance of the accounts, after providing for the payment of the half-year's interest, and the usual dividend of £2 per share (which the committee now recommend to be paid free from the income-tax), shows a surplus of upwards of £9,000."

In other cases, where the canal companies have not tied their hands from competing with rival railways, as the Birmingham Canal Company have done by their compact with the Birmingham Railway, the truth of the first of the reasons alleged at Crewe has had opportunity of being tested: and the result has been, to speak generally, to confirm and establish its truth; and Lord Ellesmere on his waters, and the Birmingham and Worcester Company on theirs, to name no others, can tell the world that they have ceased to dread any evil effects from railway competition, through fear of which the former received (according to report) from £80,000 to £100,000, by way of compensation; and the latter unprofitably expended several thousands in an abortive railway speculation.

It remains to be seen whether the third of the reasons alleged at Crewe in 1844, for preferring canals to railways for investment—namely, "that while human ingenuity has been taxed to the utmost to facilitate locomotion on railways, little or no attention has been bestowed upon the improvement of inland navigation,"—is as sound as the others (apparently) have proved to be: in other words, "*whether inland navigation is not capable of very great improvement.*" This shall be the subject of the next chapter: before entering upon which, let it be well-considered, by way of encouragement to turn attention to the subject, that *a very little improvement* will suffice to bring upon the canals the whole or almost the whole of what forms the chief source of revenue on many railways—namely, the conveyance of live stock. No grazier, or butcher, it is believed, will be found to affirm otherwise than that, if the choice were offered to him, he would choose rather to convey the stock that he has to sell, or kill, by water than by rail.

Chapter II.—*On the Improvement of Inland Navigation.*

When the mind has once been directed to devise means of rendering our lines of inland navigation more available than at present they are found to be for the commerce of the country, the small degree of attention which has as yet been bestowed upon them is apparent at every turn. Of the matters calling for amendment, some are obvious to every passer-by; others require consideration to be noted; others again require argument and proof. Again, some are in the power of the parties trading upon the waters; others in that of the proprietors or trustees of the waters; others again require either extension, combination, or the interference of the legislature.

I. Let those matters in which the want of amendment is manifest to all be first considered. Of such let these be named:—1st. *The style and condition of the animals* usually employed in the traffic. Generally speaking, these are the worst of their kind, disabled, low in condition, ill-groomed, ill-fed,—a striking contrast to those employed in land carriage.—2ndly. *The state of the trackways.* Natural earth, mud, water, deep sand, slippery chalk. Contrast these with the roads and ways employed in land traffic. By the sides of other roads care is taken to keep the cattle from trespass-

ing; here nothing of the sort is attempted. On other roads, all gates, except in cases of extreme necessity, and then with some person to watch them, are carefully excluded. On these, there is usually a gate at the end of every field, the hedges running down to the water: as if a premium had been offered for the multiplication of causes of obstruction.—3rdly. *The attendance at the locks*, which correspond to the turnpikes on land roads. On land-travelling a turnpike-house is a necessary adjunct to a turnpike-gate, as close as possible. But where in water-travelling do we find lock-houses—or, if found, at what distance are they situated from the locks intrusted to the care of the occupiers?—4thly. *The construction of the bridges* so low down to the water, as to leave no room between them and it for an ordinary load to pass.

II. Among the matters in which the necessity of alteration will, probably, be admitted as soon as pointed out, are these:—1st. *The application of artificial locomotive power*. In this respect, it must be acknowledged that England is somewhat in advance of her neighbours, for she has attained to horse-power on trackways; whereas, in the inland navigation of the continent, when the wind fails, the means of locomotion usually had recourse to are either shoving with long poles; or ropes made fast to posts and drawn in by direct hand draught; or men and women yoked like brute beasts, with broad belts over their breasts, upon which (even women's breasts) the weight of the draught appears to be borne,—a sight sickening and revolting. England is in advance of these, and for such brute labour has applied brutes instead of human beings; but still only for direct draught: the living horse has as yet not been applied to leverage in this service [as is used in Canada]; nor have those cheapest and most obvious of all artificial powers, the water-wheel and the wind-wheel, been as yet applied for a purpose for which in so many cases they are so admirably adapted; nor stationary steam-engines, except in one or two instances. In a few cases, paddle-wheels have been called in, which, on many accounts, are the most undesirable of all for this particular service.—2ndly. *The construction of the barges:* first, as to their *material*, which, in almost all cases, now is of wood, more expensive, less durable, heavier, and more bulky than iron, to a very considerable proportion; secondly, so that the barge may float *on* the water, and not *below* its level, necessitating the drawing *through* it. What the specific gravity of atmospheric air is, seems a point not easy of solution, seeing that the barometer exhibits a perpetual fluctuation; but the specific gravity of water is stated on good authority to be 62½ lb. to the cubic foot. When it is considered that for every cubic foot of barge below the water-level, 62½ lb. weight of water has to be moved at every inch, one would have thought the attention of all concerned would have been directed to carry as much of the cargo above and as little below as possible. But, somehow or another, a diametrically opposite course is almost universally adopted: about three inches of the barge appears above the water-line, and all the rest is sunk below—so that the greatest resistance which the case will permit is carefully secured.—3rdly. *The means of ascending or descending from one water-level to another*. As yet, in England, we have attained only to the old lock, and that so constructed as to afford the chief cause of detention in water conveyance. The consumption of time, the strain upon the cattle, the wear and tear of tackle, now required in drawing a deep-laden barge into a lock, are well known to all who have to do with inland navigation. Yet, apparently, it requires little contemplation of a lock, to see how (even without altering the construction of the barges, and still dragging the goods *through* the water) an immense saving of time and labour may be effected, by a slight alteration: while the field for invention and experiment in perpendicular lifts and inclined planes is as yet almost unoccupied; only our neighbours in the United States of America have lately adopted one species of the former, while those in China have of long time very extensively employed the latter—of which some account and drawings are to be found in Lord Macartney's Embassy.—4thly. *The supply of water:* both in the saving it at the change of levels, and in securing supplies in dry weather, all must see how much remains to be done; while, few, probably, who apply their minds to it, will consider any great difficulty to lie in the way of improvement.

III. Of matters calling for improvement, which it requires argument or experiment to establish, it will suffice to suggest one, of a mechanical nature—which is, *the point of draught;* to which, at present, as far as appears, no attention has been paid; but which, it is hard to conceive to be a thing indifferent. But of this class, the most important is the jointed system of our lines of inland navigation—broken into short pieces, under distinct governments, like the turnpike trusts; but attempting against one another a system of injury, which the trustees of turnpike roads have, apparently, never contemplated. Between London and Birmingham, for instance, there are as many as four such, at least. It is in vain that one, two, or three of these concur in meeting the public convenience and their own general interests, by reduction of tolls or any other combined improvement, as long as it is in the power of the remaining portion or portions to profit by the reductions of the others, by either maintaining their own tolls at the unreduced rate, or even raising them in the face of the reduction of others; both of which cases are found not unfrequently to occur.

CHAPTER III.—*On the Formation of Inland Navigation Conveyance Companies.*

The only apparent method of overcoming the last-named difficulty in the way of the improvement of inland navigation—namely, that arising from the division of interests at work upon all our chief lines (apart from direct legislative interference, which is the last and least-desirable remedy,)—is the formation of conveyance companies throughout a whole line; offering to all the different navigation companies along the line, shares according to their mileage; and to all the parties already trading on those navigations, shares according to the amount of capital already embarked in this employment. By this means it should seem not merely practicable but easy to unite, for the common benefit of all, those interests, the confliction of which at present is found to be injurious to all.

The writer, who is a clergyman, and who has turned his attention to the improvement of this department of human industry, chiefly, or rather solely, with the view of making it subservient to the best interests, present and future, of mankind, has already in several quarters privately put forward suggestions for the formation of such companies, which have hitherto been generally favourably received;—he now desires to submit them more extensively to the consideration of his fellow-men, based upon this condition, which he has invariably exhibited—namely, *That provision for the spiritual and educational wants of all the employées of such a company, and of all who are called into being (by the encouragement given to marriage) by its prosperity—and also for their bodily wants, in sickness, accidents, and superannuation—shall form a first and necessary item of such company's expenditure to an extent not exceeding one-tenth of the whole.*

How extensively such a principle, if generally adopted by our great companies, would tend to the amelioration of society, and the comfort and well-being of all classes, drawing them together by the surest bonds of Christian faith and love, there can be no need of words to demonstrate. The more each man contemplates it in his own breast, the more (the writer believes) it will be found to commend itself, alike acceptable to God and approved of men.

Taking Birmingham as the centre of British industry, such companies may obviously with advantage be formed, respectively, on the following main lines, omitting for the present the consideration of the less important:—1. Birmingham, Worcester, Gloucester, and Bristol; 2. Birmingham, Chester, and Liverpool; 3. Birmingham, Manchester, Leeds, Halifax, and Hull; 4. Birmingham and London; 5. Birmingham and Chichester. Again, 6. Hull and Liverpool; 7. Hull and London; 8. London and Bristol; 9. London and Chichester.

To complete the line of inland navigation from Birmingham and the manufacturing districts to the British Channel, there needs but to connect the Grand Junction with the Colne, a cut of one or two miles, which falls into the Thames at Egham, from which the outlet is at Weybridge; and so by Guildford and Arundel. This at present neglected, but surely most important, line from London to the British Channel, either into Arundel or Chichester—that is to say, Langston harbour—is quite complete. By it, if a proper company were formed, and the commonest appliances brought to bear, goods discharged in either of those harbours could be landed at London-bridge easily within twenty-four hours, at a highly remunerative charge of ten shillings per ton, covering all. Thus, in time of war, all the hazard to our merchandise which the Duke of Wellington has prognosticated from French steamers in the little French ports, with the sun always on their backs, would be obviated, and the incalculable expenditure contemplated in the acknowledgedly-hopeless undertaking of making a Harbour of Refuge at Dover would be superseded. And at all times the risk of insurance from weather, the chief part of which from China to London is calculated on the passage through the Straits of Dover and round the coast of Kent, to say nothing of delays incalculable, would be removed. The present unoccupied harbour of Langston is of size to receive in safety the whole merchant fleet of the country. Again, by continuing the navigation of the Wey beyond Godalming in the direction of Alresford, and extending the navigation of the Itchin, with a cut of five or six miles to unite them, another line of inland

navigation from London to the Channel would be completed; and by continuing the navigation of the Test or Auton to Whitchurch or Ash, with a cut of five miles to the Basingstoke canal, a third line would be completed: and Langston, Arundel or Littlehampton, and Southampton become the ports of London.

On the other side of the Irish Channel, conveyance companies between Dublin and Waterford (by the Barrow navigation, as thriving a water concern as any in the kingdom, and the receipts on which last year were greater than ever); and between Dublin and Limerick (by the Grand Canal, one of the finest in the kingdom, and the Shannon), obviously present themselves. A cut of three miles, or thereabouts, connecting the Slaney with the Barrow, would bring Wexford within inland navigation of Dublin. A cut of about the same length from the Grand Canal at Ballinasloe, into one of the small rivers that run into Galway Bay, would connect, in the shortest line, the Atlantic with the Irish Sea.

It is believed by the writer that every one of the twelve or fifteen lines here enumerated will be admitted by all practical men to present, if properly conducted, as safe openings for capital and industry as any in the kingdom.

REVIEWS.

A Guide to the Proper Regulation of Buildings in Towns, as a means of Promoting and Securing the Health, Comfort, and Safety of the Inhabitants. By Wm. Hosking, Architect & C.E. London: Murray, 1848.

Mr. Hosking's book may be taken as one of the signs of the times, and therefore we give our attention to it, and recommend it to our readers. The outcry for sanitary reform can no longer be unheeded; it has led to a practical movement, which must go on. The architects, engineers, and medical men, who created this movement, and have fostered it—and we rejoice that our publication has been found among the earliest advocates—may feel justly gratified that their proceedings have at length received the countenance and co-operation of the legislature. Those, however, who have held back, or thought that the agitation had no practical authority, and was merely a noise about trifles, must now bestir themselves, or they will be left behind by their more enlightened compeers. Obstinate adherence to old prejudices has already brought public ridicule on several men of standing; and reputations which have cost scores of years to build up are at once knocked down, when it is found that the parties have for scores of years been wasting the public money, in the despite of every warning. The public are now awakened, and they require at the hands of architects and builders a degree of knowledge as to structural arrangements, which formerly was never thought of. For all the better class of buildings it is no longer enough to run up a set of walls and to line them, but the buildings must be made habitable otherwise than by being mere shelters against rain. They must have proper provision for lighting, warming, ventilation, and sewage; matters about which employers and builders thought very little some years ago. The reports of the Sanitary Commissioners, the labours of Messrs. Roe and Phillips, the work of Mr. Hosking, are landmarks, whereby professional men may note the set of the current, and observe the disposition of the authorities to carry out to the full what used to be laughed at as the theories of sanitary reform. Mr. Hosking, of course, disclaims any official character for his book; but his station as one of the Official Referees for Metropolitan Buildings, will, in the eyes of the public, give an official character to his book in despite of himself; and most of what he says is so reasonable, that it will work its way with the legislature, the public, and the profession, all of whom his book interests.

Although it is perfectly true that the improved system of structural arrangements has arisen mostly from the labours of architects and engineers, yet it has not been fostered so generally among the profession as is desirable. Indeed, the public at this moment are ahead of architects and builders—a state of affairs which cannot long continue with comfort to the latter. This arises, we fear, from a want of appreciation of the value of professional literature, and therefore the want of a laudable spirit of investigation and information. If it be remembered that until our *Journal* was established, no architectural periodical had been able to maintain itself, this will show what the state of affairs formerly was; but though the number of years which this *Journal* has existed is a proof that we have effected a change for the better, we cannot but be sensible that architects are not so much alive as they ought to be to the cultivation of professional learning. To advert, as an instance, to our own publication, we feel well assured that by a great number of our readers our earlier remarks on sanitary and structural arrangements were passed over as being of no interest, or as not being immediately practical, because the reader did not take the trouble to investigate and search out for himself the truth or justice of our arguments. The consequence has been that many, instead of being gradually led and prepared to a practical appreciation of the subject, wake up as it were suddenly to a consciousness that they have got to learn a great deal immediately and with some trouble, which they might have learned slowly and easily. We have sometimes met with remonstrances because we have given attention to questions which were thought the whims of the day, but the importance of which is now recognised by all, though it should be remembered, that a periodical like our's is a link between the public and professional men, for those of the public who feel an interest in professional pursuits, or seek for information, naturally apply themselves to such a recognised source. Hence we have been enabled on many occasions to forward professional interests, and to awaken attention among the public, so as to insure co-operation in carrying out measures which were desirable. In reference to the present question of sanitary reform, however, it is particularly incumbent on professional men to apply themselves to it, or otherwise medical men and others will put themselves forward to secure, if they can, some greater share than fairly belongs to them in the new arrangements.

Mr. Hosking's book must be read by the architect and builder, because it is just the kind of book which will be read by the employer. The committee of a club who desire a superior house, the gentleman who wants a comfortable mansion, the merchant who requires a safe warehouse, the board of guardians who advertise for a healthy workhouse, are likely to look into the work before us, as a guide to the best modes of securing the health, comfort, and safety of a building. Perhaps Mr. Hosking has a leaning in favour of timber and against iron, and in favour of brick and against stone; but we hardly like to say this, for there is so much candour in stating the case, and so much practical knowledge displayed throughout, that we believe Mr. Hosking is about as fair a guide as we have yet had upon structural arrangements. There is very little of his book which is new, and it is hardly likely that there should be; but what there is new, is the careful and close consideration of what is the best and most practical mode of reaching any given end: and this may be called new, for we fear it is too general to run up buildings without the least consideration of their fitness for the purposes to which they are applied. It may be said shortly that the houses of the metropolis are made dangerous to life from their combustibility, and to health from their want of ventilation; while the sewers are so made as to form an elaborate machinery for poisoning the population, for cutting off the infant in its cradle, and taking years away from the life of every inhabitant of this immense and thickly-peopled city.

We have said that Mr. Hosking is unfavourable to the use of iron under some circumstances, and it will be useful to lay before our readers his remarks upon the subject. He says—

"There is no kind of economical structure that resists the action of fire so perfectly as brickwork does, and any structure wholly of bricks, set in and combined with proper mortar, may be deemed for all economical purposes a fire-proof structure. But floors and roofs, or roof coverings, cannot be formed in brickwork alone, without the sacrifice of space and materials, to so large an extent as to render such a mode of structure inconsistent with a due regard to economy in those important particulars. Means are to be sought, therefore, by which brickwork may be rendered available, to the greatest extent possible, consistently with economy of space, and, if it may be, of materials also. For this purpose iron presents itself as a substance wholly incombustible, and capable, in the form of beams and girders, of bearing over space horizontally, and so as to leave, for economical purposes, a large proportion of extent in height, which brick vaulting would absorb; and, requiring no such absorption of space as brick vaults require for their lateral abutments, iron, employed as a means of vertical support, in columns or story-posts, will give the requisite strength to that effect in far less space within an enclosure than brickwork requires in piers or pillars to give the requisite bed to the springings of vaults, and to carry the weight of brick vaulting. But iron, although incombustible, is fusible under the action of intense heat, and is, in its more economical condition, frangible if suddenly cooled when hot; without reference to its generally brittle character, or to the uncertainty which attends its manufacture, when applied in that condition. Beams, girders, and columns or story-posts, of wrought-iron, if such things could be produced in wrought-iron economically, would bend when exposed to a high degree of heat, and let down any structure that had been made dependent upon them; whilst beams or girders of cast-iron break when dashed with water; and columns of the same substance are liable to

soften and yield, as well as to snap; in either and in any case, involving the ruin of the buildings, the destruction of the property confided to them, and danger to the lives of firemen or others within reach of the ruin.

So great is the danger apprehended from the treachery of cast-iron in buildings on fire, that the men of the London fire-engine establishment, who go unhesitatingly, in the execution of their duty, into burning buildings, are prohibited from going into parts or places which depend upon supports of cast-iron, whilst they are allowed to trust themselves to burning timber almost at their own discretion—a quality for which they are not, indeed, so remarkable as they are for headlong and gallant daring.

Cast-iron is constantly recurred to, nevertheless, as a means of economising space in the formation, and largely also in the support of the floors of buildings which it is desired to render proof against fire; and it is certain that the use of beams, girders, and story-posts of cast-iron tends to that effect: that is to say, the liability of the building to take fire is lessened by the use of iron in place of wood, but for the purpose under consideration—power of resisting the action of fire when it occurs to matters stored in a building, and is fed by such matters independently of the substances employed in the structure of the building—iron requires to be itself protected from the action of the fire."

Mr. Hosking goes on to suggest the mode in which iron can be safely used for floors and ceilings; but he adheres to the opinion that if pillars must be used, they should be of brickwork.

We ourselves have witnessed the danger of using cast-iron in exposed situations in buildings. We recollect, within the last four or five years, the fire at Fenton's wharf, London Bridge, where the warehouses were supported upon cast-iron bressummers, and which, through being heated by the fire, and the cold water of the engines falling upon them, were cracked, and in consequence the superstructure was obliged to be taken down. In other situations, we have seen the fronts of houses erected on timber bressummers which have withstood the ravages of the fire, an external coating of about an inch in depth of the timber being only injured by the flames.

The preservation of life from fire is an object in which Mr. Hosking deservedly takes great interest, and he has brought to bear the results of his remarks on buildings at Paris, which we wish we could transfer at some length to our own pages. After recommending that party-walls shall be reduced to one-brick thick, on condition of cross-walls or partitions being built throughout the house of one-brick thick, and after stating the danger of the hollow quartering partition generally used, he describes the system he observed in Paris.

"The plan referred to is, to frame and brace with timber quarterings much in the manner practised in England, except that the timber used in Paris is commonly oak, and is very generally seasoned before it is applied in building in the manner referred to; and that, as before remarked, the carpenter's work, or *carpentering*, of the French is not so good as that of the English. The framed structure being complete, strong oak batten-laths, from two to three inches wide, are nailed up to the quarterings horizontally, at four, six, or even eight inches apart, according to the character of the work, throughout the whole height of the enclosure or partition; and the spaces between the quarterings, and behind the laths, are loosely built up with rough stone rubble, which the laths, recurring often enough for that purpose, hold up, or prevent from falling out until the next process has been effected. This is, to apply a strong mortar, which in Paris is mainly composed of what we know under the name of plaster of paris, but of excellent quality, laid on from or upon both sides at the same time, and pressed through from the opposite sides so that the mortar meets and incorporates, imbedding the stone rubble by filling up every interstice, and with so much body on the surfaces as to cover up and imbed also the timber and the laths;—in such manner, indeed, as to render the concretion of stone and plaster, when thoroughly set, an independent body, and giving strength to, rather than receiving support from, the timber."

The same plan is applied in Paris to the stairs, and Mr. Hosking recommends it for adoption here. He likewise gives a detailed account of the French mode of making ceilings and floors.

"But the French render their floors also so nearly fire-proof as to leave but little to desire in that respect, and in a manner attainable with single joists, as well, at the least, as with joists framed into girders. According to their practice, the ceiling *must* be formed before the upper surface or floor is laid, inasmuch as the ceiling is formed from above, instead of from below.—The carpenters' work being complete, strong batten-laths are nailed up to the under sides of the joists, as laths are with us; but they are much thicker and wider than our laths, and are placed so far apart, that not more, perhaps, than one-half of the space is occupied by the laths. The laths being affixed—and they must be soundly nailed, as they have a heavy weight to carry—a platform, made of rough boards, is strutted up from below parallel to the plane formed by the laths, and at about an inch below them. Mortar is then laid in from above over the platform, and between and over the laths, to a thickness of from two inches and a half to three inches, and is forced in under the laths, and under the joists and girders. The mortar being gauged, as our plasterers term it, or rather, in great part composed of plaster of paris, it soon sets sufficiently to allow the platform—which, it will be readily understood, has performed the same office to the mortar which centering performs to the parts of an arch or vault—to be removed onwards to another compartment, until the whole ceiling of any room or story of a building is formed. The plaster ceiling thus formed, is, in fact, a strong slab or table, in the body of which the batten-laths which hold it up safely in the air are incorporated, and in the back of which the joists, from which the mass is suspended, are imbedded. By the process, the under surface of the plaster table has taken from the rough boards of the platform the roughness requisite to facilitate the adhesion of the finishing coat of plastering, which is of course, laid on from below.

Whether the eventual surface is to be a boarded floor or not, however, the flooring joists are covered by a table of plaster above, as completely as they are covered by a plaster ceiling below.—Rough battens, generally split and in short lengths, looking like ends of oak pales, stout enough to bear, when laid from joist to joist, the weight of a man without bending, are laid with ends abutting upon every joist, and as close together as they will lie without having been shot or planed on their edges, so as to joint them. Upon a rough loose floor thus formed, mortar of nearly similar consistence to that used for ceilings, but not necessarily of the same good quality, is spread to a thickness of about three inches; and as it is made to fill in the voids at the ends and sides of the floor-laths upon the joists the laths become bedded upon the joists, whilst they are to some extent also incorporated with the plaster, and the result is a firm floor, upon which, in ordinary buildings, and in the public and commoner apartments of almost all buildings, paving-tiles are laid, bedded and jointed in a tenacious cement to form the working floor.

It may be added in explanation of the statement, that in Paris the practice of forming a table of plaster over the joists when tiles are to be used as the flooring surface, is employed also when a boarded floor is to supervene,—that as the surfaces of the true joists lie under the mortar or plaster table, a base is formed for the boards of what English carpenters would call stout fillets of wood about 2½ inches square, ranged as joists, and strutted apart to keep them in their places, over the mortar table, to which they are sometimes scribed down, and that to these fillets, or false joists, the flooring boards are secured by nails; so that in truth the boarded floor is not at all connected with the structure of the floor, but is formed upon its upper coat of plaster. The wooden floor thus becomes a mere fitting in an apartment, and not extending beyond the room nor over the passages and landings to the stairs, the floor in any room might burn without communicating fire to the stairs, which, in their turn, if they could burn, could hardly endanger the immediate safety of any inmate of the building, because of the complete separation which the tiled and plastered floor of the landings effects between the wooden stairs and the several apartments."

The author remarks that a similar floor is used at Nottingham, where the houses are said never to be burnt, and are free from damp and vermin.

Mr. Hosking objects to timber being laid bedwise in walls, or joists being let into them, but recommends that the rafters be let in and properly secured against fire.

We may observe, upon a note of Mr. Hosking's as to Flemish bond, that he says he never saw Flemish bond in Flanders, at Rotterdam and the Hague, Antwerp, Brussels, Liege, Cologne, Mentz, and Frankfort. Now there is only one of these towns in Flanders, and this is no proof that Flemish bond is not to be found at Ghent, Bruges, Courtrai, Ostend, Ypres, Dunkirk, Lille, or other towns in Flanders.

Of French carpentry, Mr. Hosking says that it is much behind our's, so that in framing the floors no important bearing is, or indeed may be, trusted to the framed joint, dognailed stirrup-straps of iron being always brought in aid. He says, however, that their boarded floors are always tongued in the joints, and almost always parquetted, and so resolved into compartments of various figures, and being tongued and edge-nailed, no nail or bradheads appear upon the surface to dot over and disfigure the floors, which being for the most part of wainscot, are far more sightly than the best executed deal battened floor with us.

With regard to Parisian masonry our author states,

"It is by means of the girder bearing upon the solids of the walls, though with bad carpenters' work, or *carpentering* rather, that the French are able to carry up their soft stone rubble walls to heights that would frighten even a London builder, and that would certainly be unsafe if the walls were seamed with wooden plates, and shaken by floors of single joists. The author, being at Paris in 1846, measured the thickness in the ground-floor story of a newly-built coursed-rubble party-wall, in the Rue de la Banque (the Gresham Street of Paris), and found it to be exactly 18 English inches in that part, whilst the total height of the wall was not less than 85 feet. The wall ran up of that same thickness through six stories, a height of not less than 65 feet, and was terminated by a gable of from 12 to 15 feet high, of the same kind of structure; and there was besides a vaulted basement story, throughout which the wall might have been 20 inches thick, as other similar walls then in progress to neighbouring buildings proved to be. And it is by means of the solidity given to the floors by the girders, and the solid bearings which the girders obtain, that the floors are able to carry the dead

weight of matter which renders them practically fireproof, in addition to the moving weights to which the floors of buildings are necessarily exposed to use."

Among Mr. Hosking's objections is that to the use of concrete as a mere footing for walls, from the notion that a foundation is thus rendered strong by depth; whereas he advocates the use of a thinner layer of concrete over the whole foundation, so as to gain strength by an increase of base.

Another objection he entertains is to the wooden skirting-board, which causes filth, discomfort, and danger, as it is often too close to the chimney flue. He also considers that the deep boxings for window shutters gratuitously make a house more inflammable, and he recommends metal roller-blinds instead.

We do not think Mr. Hosking dwells too much upon the precautions to be taken against fire; and if any of our readers do, we recommend to them the following justification:—

"It appears from an estimate appended to a Report by Mr. Fairbairn on the Construction of Fireproof Buildings, with Introductory Remarks by Mr. Samuel Holmes, published at Liverpool in 1844, that the insurance-offices paid for losses by fire in Liverpool alone, in the ten years ending December, 1842, the sum of 1,121,427*l.* This sum does not, of course, include the losses of, and other injuries to, the poor who do not insure, but who are always great sufferers in cases of fire; and some of the fires which occasioned the losses were extensive conflagrations, in which lives were lost in the attempts made to subdue the fire; nor does it include a probably large amount of property not sufficiently insured to cover the losses.

Urged by successive calamities by fire, and by the high rates of premium which the insurance offices were compelled to exact to enable them to meet the losses, the people of Liverpool applied to Parliament at length, and obtained, in 1843, an Act to compel themselves to abide by certain wholesome regulations, as it regarded the security of buildings from fire. The effect of this Act, 6 & 7 Vict. c. 109, and the provision of a supply of water available in case of fire, has been to reduce the rates of insurance considerably; but the protective measures are estimated to have cost from 200,000*l.* to 300 000*l.*, which being added to the losses above stated, with a trifling addition for the losses not included in the estimate, will show an annihilation of property in one town alone, and within ten short years, to the enormous amount of a million and a half of money."

The author is not quite clear upon the subject of ventilation—but then it is in its infancy: still his remarks are well worthy of perusal.

In conclusion, we may observe that Mr. Hosking has rendered a great service to the profession by the publication of this book, as a useful work of reference, and as a vindication of the practical claims of the architectural profession to their proper share in structural arrangements.

Railway Practice. By S. C. Brees, C.E. London: Williams and Co., 1847. Third and Fourth Series.

These are two large volumes with a profusion of plates, forming the third and fourth of the series of railway practice. They are translations from the *Portefeuille des Chemins de Fer*, by Messrs. Perdonnet and Polonceau, but derived from English materials. It is a curious thing that we should be indebted to the French for the description of our own railway works, and that there should be a want either of enterprise or zeal to publish an original account. So it is however that we are particularly deficient in accounts of our great engineering works, and this from three causes: that our great engineers have no time to write, that our young engineers have no ability to write, and that engineers generally do not buy nor read works when published. Thus we are often served at second-hand with accounts of our own works by Frenchmen, Americans, Germans, or Russians, and after the experiment has been made abroad, we get confidence enough to make a trial here. We are, perhaps, the more indebted under such circumstances to those who, like Mr. Brees, take the trouble and the risk of making us acquainted with our own works. In the present instance, we have from Mr. Brees two volumes, which will be found invaluable as records of the best practical examples of railway engineering. If we have any fault to find it is that he has not sufficiently reduced the French measurements, a labour which if performed by him or his assistants would have saved that of his readers.

The third volume is devoted to earthworks, permanent way, blocks and sleepers, rails and chairs, with turn-tables, sidings, and switches. The fourth volume describes stations, carriages, trucks, water-cranes, and station plant.

When we say that there are more plates than text, we think we offer a very strong recommendation of the work to the practical man. These plates too are filled with details, so that nothing is wanted to give a correct idea of everything described.

Among the plates are:—The forms of every kind of rail in use in England and elsewhere; machinery used for making rails; navigators and platelayers' tools; switches on various plans by Robert Stephenson and others; turntables of the London and North Western, Midland and Great Western railways; locomotive turntable; weigh-bridge; level crossings and gates; double and single hoist bridges; crossings for temporary works; earthwagons of the London and North Western and Great Western; Mr. Jee's Garton station on the Manchester and Sheffield; bridges over the Wear, Clyde, and Meuse; viaducts on the Manchester and Sheffield, and Manchester and Leeds; culverts on the London and North Western. Among the carriages are those of the London and North Western, Birmingham and Gloster, Great Western, of French, German, and Belgian railways, with details of the wheels, axles, frames, buffer-springs, and breaks. These plates of carriages include passenger and mail carriages, horse-boxes, trucks and goods wagons. This part is of particular value at a time when the influence of the carrying stock on the structure and working of a line is the point which most affects the engineer. As the plant increases, and the necessity for economy in the working becomes greater, the attention of the engineer is well bestowed on a knowledge of the best construction of carriages, and the most efficient means of improving them. Hitherto very much attention has been given to the locomotive, and to systems of atmospheric traction, but a more immediate reference to the load to be carried is the point to which the engineer will for some time have most to direct himself. The establishment of lighter engines and smaller trains will call for a great deal of ingenuity to provide plant suitable for such a different system of traction.

Mr. Brees gives many examples of large stations and their details. Among them are the South Western at Nine Elms, the Euston-square terminus, the Birmingham terminus, the Nordbahn station at Vienna, the Brunn station on the latter line, stations at Versailles and Pecq, the terminus of the Versailles line at Paris, the Dublin and Kingstown terminus, and the Leeds station. Besides these leading termini and stations, plans are given of intermediate stations, as Tring, Watford, Wolverhampton, Newton, and Coventry, on the London and North Western; Thames Ditton, on the South Western; Reading and Slough, on the Great Western, and numerous places on foreign lines. Many of these stations, as those on the Paris and Rouen, are the work of English engineers, and it is gratifying to perceive that many details introduced by them have served as an example to their foreign brethren. The study of the foreign plans by English engineers will enable them to return the compliment, because the experience and ingenuity of the many men of ability employed abroad cannot fail to be productive of many valuable improvements.

In conclusion, we can only repeat what we have said in the beginning, that Mr. Brees's work will be found most useful to the engineer. It is a repertory of every practical detail connected with railway works, and it has the advantage of presenting copious examples under every head of reference. With these words we commit the work to the hands of our readers, being fully satisfied that it is well worthy of their support.

Designs for Schools and School-Houses, Parochial and National. By H. E. Kendall, jun., Architect. London: Williams and Co., 1847. Folio.

Next to churches, schools are perhaps the class of buildings most in request, owing to the necessity that is felt for providing education for the poorer and humbler ranks of society. Numerous buildings of the kind have accordingly been founded and erected of late years, yet very few are so satisfactory in point of design as they might have been rendered, at the same, or very nearly the same cost, merely by the application of a little study and judicious taste. Or if it be deemed of no moment of what kind the taste shown in such structures be, it is safer as well as more economic to attempt nothing more than what utility absolutely demands. We agree with Mr. Kendall when he says, "although some of the national schools lately erected are very creditable to their respective architects, the general result of the great movement apparent in the building of churches, schools, &c., redounds rather to the honour of resuscitated zeal than to that of architectural talent. So great is the tameness, and so apparent the mediocrity of conception, both in arrangement and style, in many of them, that were it not for the good they effect, we should regret their very existence." As regards the utter tastelessness frequently shown in things of the kind, blame rests as much with the employers as with the employed, since it is the ignorance of

the former—their incompetency to judge of designs submitted to them, together with their childish determination to exercise the privilege of pleasing themselves without being accountable to any one for what they do—that encourages so much paltry design. The *tel est nôtre plaisir* will not excuse deformity in the eyes of others, who will in turn exercise their own privilege of expressing censure and ridicule where they are deserved—a consideration that ought to be seriously taken to mind by those who have the directing of far more important edifices than school-houses.

"Something of external comeliness"—we again quote from the preface—"should be assigned, as matter of course, to the humblest of such erections; and, under the direction of good taste, usefulness of purpose and beauty of design may be made mutually to subserve to each other, even when the latter is but a secondary consideration." It may be further observed, that it is not so much positive beauty as well-marked character and effectiveness of *ensemble*, that ought to be studied for buildings in which a certain degree of homeliness is no more than becoming. And this has upon the whole been well accomplished by Mr. Kendall—though, as was to be expected, more happily in some instances than in others. The collection consists of both executed and unexecuted designs, each of which is shown in a perspective or pictorial view of it, as well as by a plan and elevation; and there is also letter-press to each subject, containing remark as well as mere explanation. The unexecuted designs are five in number; the others are those of the following buildings which have been erected by the author: Childerditch School, Essex; the Poor Boys' School, the Poor Girls' School, and the Commercial School, all at Bury St. Edmund's; the building for the Battle and Langton National Schools, at Battle; Willesden School; and the Infant School at Stanmore, which last is said in the account given of it to have been erected in 1845, "at the sole expense of Miss Martin, a lady distinguished during her residence in that beautiful village for her benevolence and extended charities."

All the designs may be designated Old English in style, although it is not that of one and the same period; nor do they all show the same mode of construction, some of them being in imitation of the "half-timbered" houses, others of red brick with stone dressings and quoins. The Elizabethan style has been applied very happily in what strikes us as being the best design of all—namely, the school buildings at Battle, in which, while the character of the style itself is not only well kept up but expressed with gusto, the character of the particular kind of building is most unmistakenably pronounced. Although perfectly regular, both in the arrangement of its masses and the features of its elevation, the whole composition, as shown in the perspective view, is pleasingly varied and highly picturesque, yet sufficiently sober withal. The last subject, design No. 5, shows a rather extensive and complex group of buildings in the Tudor style, and in perspective makes a very picturesque composition. Independently of the interest and merit of the designs themselves, the artistic skill displayed in the pictorial representations of them cannot fail to excite admiration. They are very superior productions of their kind,—studies of trees and figures as well as of buildings. Owing to which, to the subject itself, and to the tasteful manner in which the work is got up in every respect, we may anticipate for it a highly-favourable reception even among those who hardly make any pretensions to amateurship in architecture.

HISTORY OF ARCHITECTURE.

We have received the following communications in reference to Mr. Elmes's papers, and which we lay before our readers:—

SIR—In your *Journal* for November last, page 338, there is a statement which, I fear, may lead some of your readers into error. In the life of Stuart it is said, "Preparations for his works were made with such rapidity, that in 1768 they were presented to the public under the title of 'The Antiquities of Athens, &c. &c.' 4 vols. folio, 1768." Now, the First Volume was published, as my two original copies show, by Haberkorn, in 1762, and nothing is said in the title-page of four volumes (although in the body of the work two more volumes are referred to, and *two* only); it is distinctly marked Vol. the First. Vol. II. was published by Nichols, in 1787; Vol. III. also by Nichols, in 1794; and Vol. IV. by Taylor, in 1816—that is, not till 48 years after the time above referred to.

In page 340, in the life of Sir Robert Taylor, is one of those commonplace and sweeping attacks so constantly directed against the late Building Act, and in which I never did, and do not now, join. That it had some defects, as well as some omissions, I am free to own, as well as that in these respects it required alteration—perhaps in no respect more than in its provision for the payment of expenses of party-walls by the owner of the improved rent, a term which the result proved to be alike uncertain and unjust. But that it was infinitely better as a whole than its successor, is, I believe, now almost universally admitted, and I could wish those who so lavisly condemn the late Act in the bulk, would condescend to explain more fully those particular parts of it against which their attacks are directed, or to which they object.

A CONSTANT READER.

SIR—The series of articles entitled a "History of Architecture in Great Britain," contains some opinions and remarks that appear to have been uttered rather hastily. I hope, therefore, you will allow me to animadvert on what ought not, for the interest of art, to be suffered to pass uncontradicted.

To begin by correcting some of the mistakes:—The design of the India-House is attributed to Jupp, the Company's surveyor, who was only employed to execute the works, the design itself being by Holland, as is explicitly stated in the biographical article on the latter in the Supplement to the "Penny Cyclopædia." Jupp certainly does not appear to have been of any note at all in his profession, therefore it is not very likely that he was the real author of the edifice; or at any rate, if such claim was to be substantiated for him, that of Holland ought to have been not overlooked but formally set aside.—In speaking of the College of Surgeons, Mr. Elmes describes in the present tense the original front, or rather the portico as it originally existed previously to the front being extended and re-modelled by Mr. Barry, who, he says, added two columns to the portico; were which the case, it either must have been at first only a tetrastyle, or would now be an octastyle one. The fact is, that instead of adding, Barry merely transposed two of the columns, taking them from the west end of the portico, and putting them at the other, thereby making what had been the first intercolumn from the east, the centre one, and so bringing it into the axis of the lengthened façade. He also fluted the shafts of the columns, and carved the bed-mouldings of the cornice. The writer's opinion of the College of Surgeons in its original state, appears to be infinitely more favourable than discriminating, he being pleased to refer to it as an "example of the genius of this tasteful architect," viz. Dance,—whereas, as designed by him, the whole front was a most barbarous and vulgar parody of the style affected for it. So far from the columns being "tastefully adapted" to the building behind them, there was no sort of adaptation at all, nor the slightest coherence in regard to character between the main building and the portico. Many may be unable to recollect what sort of figure the original front cut, but views of it are in existence, which assuredly strongly contradict the praise which Mr. Elmes has implicitly bestowed upon it.

With regard to the front of Guildhall, by the same "tasteful architect," we are told apologetically that it "is amenable to no laws." That, notwithstanding its aiming at Gothic or something of Gothic character, it is so far from conforming with as to violate its leading principles. Yet that might have been excused, had but consistent and artistic expression of its own been imparted to the façade. Though evidently very reluctant to admit anything to the disparagement of Dance, even Mr. Elmes is obliged to abandon the exterior of Guildhall to unmitigated censure and ridicule, and remark that its "faults are more than compensated for by his well-proportioned, original, and elegant chamber for the Common-council, &c." Admitting that the latter were very greatly superior to what it actually is, it would not indemnify for the positive and striking ugliness of the exterior, which of course stamps the character of the building in general opinion, and is so radical a defect that it admits of no cure short of an entirely new façade; whereas any defect or falling-short internally in such an apartment as the Common-council-room might have been easily remedied at any time.

In his quality of historian the writer has fallen into a most glaring mistake when he says that Jeffrey Wyatt was selected by William IV., as his chief architect, to enlarge and embellish Windsor Castle, it being notorious to every one, that he was employed by George IV., at the time of whose decease the works were advancing towards completion, for he had begun the new apartments. Equally notorious is it that it was George, not William, who changed the architect's name to that of Wyattville.

Wilkins is not treated very indulgently by the historian; on the contrary, is spoken of with a degree of asperity that contrasts

rather strongly with the evident disposition to touch as gently as possible upon the delinquencies of many other architects Though the general estimate of the abilities and taste of Wilkins may be acquiesced in, it seems to have been dictated by the determination not to spare him. That he was more of the scholar and archæologist than the architect—far more of the "bookish student" than the artist—is not to be denied. As to Wilkins' pedantry, that charge against him is, no doubt, founded mainly upon his having written and published so much as he did; whereas, had he never taken up the pen at all, he might have been equally pedantic in practice, without incurring the reproach of pedantry. Downing and Haileybury colleges may be abandoned to censure, as equally frigid and tasteless in point of design; but an exception from the general sweeping condemnation ought assuredly to have been made in favour of the London University College, which exhibits both classical and artistic character, and very effective play of outline. Undeniable it is that it has, even in its present imperfect state, obtained the meed of almost unqualified—not to say exaggerated—admiration from Wightwick and other professional men. Even Mr. Elmes himself did not always entertain so mean an opinion of that work of Wilkins as at present; or if he did, he thought proper to keep it to himself, for speaking of it about the time it was erected, he says: "The council obtained designs from several architects, and after due deliberation, finally adopted that of William Wilkins, Esq. R.A., a selection in which their own judgment coincided with that of almost every proprietor who inspected the drawings." This goes far to prove that, at all events, the choice was not a hastily, inconsiderate one, or managed with suspicious secrecy. Neither is there a single remark of the writer's expressive of dissatisfaction with it. Yet he now speaks not a little contemptuously of the building, without condescending to specify other objections than what is meant to be so overwhelming a one as to outweigh all beauties and merits, namely, that "the portico is, from its situation, but of little use"—nay, "a useless application, stuck up for the admiration of gazing cabmen and hackney-coachmen, whilst loitering on their stand." With what sort of reason is the loggia at the south-west angle of the Bank so highly extolled immediately after Wilkins' portico being decried? it being nothing more than a piece of decoration which does not even carry with it any semblance of usefulness.

Of Wilkins' style it is said that it was "the very mummy of the art;" yet, if it was, he unbandaged it when he designed the building in Gower-street, for even in its present imperfect state it displays no ordinary merit in regard to grouping and the fine focus produced by the central mass. As an example of a decastyle, the portico is unique among those in the metropolis,—a circumstance which an impartial and unprejudiced critic would at least have noticed;—and it acquires additional expression and stateliness from being elevated on a substructure that forms flights of steps leading up to it, which are very picturesquely disposed. In this latter respect, too, the composition may be said to be unique—certainly is very striking and artistic. As to the dome, it is of most elegant contour and design; and if it be objected to that it is a feature unknown to pure Greek architecture, the objection is a proof that those who make such futile objection are still more straitlaced and pedantic in their notions than Wilkins himself. The value of it in the composition is such that were it removed the whole would become comparatively tame and spiritless. The portico in the east front of St. George's Hospital affords another proof that the "mummy" was occasionally unbandaged. That square-pillared tetrastyle partakes more of architectural heresy than pedantry. Still the heresy, if such it be, is a welcome one, and it has been welcomed by being adopted in the façade of the new Law Courts at Liverpool, where the columniation is carried on, on each side of the central portico, in square pillars; therefore producing contrast and variety, at the same time that continuity of design is kept up.

It begins to be time to bring to a close this long letter, wherefore I will be somewhat brief in regard to what is said of Soane. As criticism, it is far more indulgent than discriminating, or in some respects even intelligible. At any rate, it is somewhat puzzling to make out what is meant by his buildings at Chelsea Hospital, and the National Debt-office, exhibiting "a wild exuberance of novelty," since so far from any thing like exuberance, they exhibit only very unequal and fitful attempts at it. His building at the Treasury, the Royal entrance to the House of Lords, and "some *others* of his *earlier* works"—though the two just mentioned were almost his very latest—are said to show "exuberance of fancy"—a mere complimentary phrase, for his fancy was in reality exceedingly limited It exercised itself only on one or two piecemeal ideas, which he dragged into all his designs, without making any thing more of them at last than he had done at first. Soane had no consistency of style,—did not even attend to keeping, but often jumbled together the most finical ornaments and the plainest features. In his building at the Treasury, the windows were as ordinary, bare, and frigid in design, as the order was rich. There was not a single touch of Corinthianism in them.

In speaking of the Lothbury Court at the Bank, Mr. Elmes again falls into inaccuracy, describing it not as it is, but as it was intended, for instead of their being two loggias there is only one, what was meant for the west one being left unfinished—a mere open screen of columns, if that can be called a screen which exposes to view most unsightly naked brick walls and mean, ugly windows. Even the opposite finished side of the court is very unsatisfactory, the interior of the loggia, though pretty enough in itself, by no means corresponding to the sober richness and dignity of the order. As to the Rotunda, it is most vilely disfigured by the equally barbarous and nonsensical wavy lines around the arches of the recesses, which seem to have been made by a stick upon some soft material while it was moist. It is admitted that the centre of the south front of the Bank "is by no means the happiest of Soane's designs," and that is treating it far more tenderly than it deserves, for it is such a decided failure and abortion that it ought to be subjected to the same process of rifacciamento as his Treasury building has been.

ZERO.

DISSERTATION ON TORRENTS.—By GUGLIELMINI.

Translated by E. CRESY, Esq., *in his Evidence before the Metropolitan Sanitary Commissioners.*

I come now to the propositions of Guglielmini, in which he pretends that a body descending an inclined plane, will not acquire a velocity greater than it would have acquired by descending perpendicularly the height of the inclined plane.

This is most true as respects solids. The elements of a solid being bound and tied together, form a heavy mass, the parts of which press each other reciprocally, and the pressure on the plane on which they rest is likewise single, as also is the direction; one velocity, one energy, and one action being common to all the parts. On the other hand, a fluid is a mass composed of lesser solid elements, but free, and not bound together by any ties, each of which can, so to speak, move in different directions and with varying velocities, press upon each other and oscillate freely. Whence the highest parts press upon the lower, oscillate, and are easily displaced when there is no impediment. When solids descend by a plane, their individual gravity alone operates; which being less than their absolute gravity, generates, at each instant, a degree of velocity less than that which their absolute gravity would have generated, wherefore solids require a longer time to descend by the inclined plane than by the perpendicular, the length of time multiplies the action of the individual gravity, and compensates for the defect of the velocity. Wherefore a solid descending by an inclined plane, has a velocity equal to what it would have, falling the same height directly. Hence the product of the action of the individual gravity, by the time of the descent by the inclined plane, being equal to the product of the absolute gravity, by the time of the fall along a perpendicular, their velocities must necessarily be equal. But in fluids the case is different. Besides the properties which they possess in common with solids, they have another, to wit, the pressure exercised by the upper on the lower part of the fluid, the which being added to the impact, increases the motion also, and hence generates a greater effect than a solid would. Neither is it absurd to suppose that the gravity of a fluid generates a greater velocity on a plane, than when acting perpendicularly, since this generates in greater time, and with a portion of gravity which in a solid which falls remains, so to speak, idle, but, in the case of a fluid, becomes active. John Bernouilli, in his works, gives a problem to find the velocity generated by a body sliding on the hypothenuse of a triangle, whose base is sustained by a smooth horizontal plane, free from any sensible friction, and moving in the direction of the base. He decomposed the force pressing the hypothenuse, or inclined plane, into two parts, one of which is employed in giving motion to the triangle, and sliding it forward; whilst the body descends on the plane, advances the triangle, and communicates thereto a certain rate of velocity; the descending body thus requires a velocity equal to that which it would have in falling perpendicularly, and the triangle has another force generated by that which presses it, whence it results that the

sum of the two motions is greater than that which a body would acquire by its simple descent. Wherefore, since the aforesaid force by pressing, generates velocity and motion distinct from that which a body, in descending, generates; in like manner it is applicable to water pressing on the lower films, and by pressing, communicating additional force to them. Besides, there are other reasons corroborative of this truth, among which is the fact, that it is necessary to spread the accelerated velocity of water passing from a larger to a narrower section over a mean of pressure.

Galileo says, "I have been carefully considering and going through various problems to investigate the acceleration of water having to pass through a narrower channel, also whether it has the same declivity in both." The greater number of authors solve the point by increasing the height of the water, and hence the pressure, thus generating a greater velocity. Eustace Manfredi thus expresses himself:—"The same water passes through a lesser as through a greater section, wherefore it is forced to pass with a greater velocity, precisely as will be the case in a vase in which the surface of the water may be at a certain height above the summit of the aperture." Guglielmini, to the same effect:—"The upper parts press the lower, and oblige them to receive a force, which being compelled to act, produces the same degree of velocity which the descent would have given them." We might quote other authors, who account for the increased velocity in narrower sections by having recourse to the pressure generated by the height of the upper parts, only they are in doubt on this subject, whether to attain so great a velocity it be necessary that the upper water should increase in height till it becomes stationary; not being able to believe that the upper water which is in the act of running is capable of producing a new increment of velocity in the lower. But experience teaches us that if the breadth of a section be diminished one-half, the water will not rise that half, as would appear necessary; if the velocity does not increase, it increases at least very little, either in section or at the base, where the reduced sections are of the same breadth, since the water retained by the narrowing of the piers of a bridge is but slightly raised. Wherefore it is necessary that the velocity increase without having regard to any new inclination, which is always the same, but only by an increase of height, which causes a pressure on the lower water which is in the act of running; whence I deduce the argument to strengthen my opinion in the case in which the velocity, arising from the inclination, is equal or greater than that which might have been generated by the pressure. Let us take two cases, one which allows the same measure of water to pass through one section twice as little as the first, preserving the same inclination, the other in which the velocity increases till it becomes twice as much.

But whence comes such an increase of velocity? what is the principle, what the nature of it? To say with Genneté, that twice the quantity of water doubles the velocity, is not to adduce a proof but to advance a mere assertion, which either supposes or requires it. I do not think that a true philosopher will perceive in the increment of so much water the principle of so great an accelcration. It behoves us to examine the genesis of such a phenomenon, and to observe the mechanism which nature adopts therein. And, firstly, two epochs of time are to be distinguished, one the first perceptible moment in which the section is reduced to half. Now, at this first instant, the water must swell and rise much above its first level, in which rise it generates a proportional velocity. But in the very act in which such a velocity is generated, the water begins to fall, wherefore the present case holds good, that the sections are in reciprocal proportion with the velocity. The water does not fall in this manner, wherefore it returns to its first level, or a little higher, there being a constant principle which compensates for a portion of the velocity destroyed by successive obstacles. Water in its course meets with continual resistance which diminishes its force, wherefore there remains in the water a constant principle which supplies and renews any decrement of velocity which the resistance may produce. Now this principle is, that whatever small increase of height above the original level causes pressure causes also velocity. Arrived at which point the water maintains the same height, which I have elsewhere designated equilibrium and constant state. Observers have not paid attention to the first epoch in which the water swells, is agitated, balances itself, but only have considered the other in which it acquires equilibrium, state, law. All this takes place so quickly that the swelling, sinking, and equilibrating hardly are evident to our perceptions. If, as I believe, the experiments of Genneté were true, according to which a river doubles or triples its water without raising its level, then it would be correct to say that it was free from any sensible resistance. This might be the case in an artificial river of short length, over a level bottom with smooth sides, and furnished with clear water. But in a natural and turbid stream, where the resistance, and that considerable, will never be wanting, it is not likely that when reduced to half its original section, it preserves its former level. This being determined, to come to the question above proposed, I resolve it thus:—Either the velocity begins to increase by the water beginning to swell, or the whole mass increases. If the first takes place, then the height being small, and hence the pressure being likewise small, the velocity generated will be also small. It is not that so small a velocity is added to so great, which it derives from an inclination, contrary to the sentiment of S'Gravesand. If the second takes place, it being then the velocity which increases, is equal to, or is less than that which results from an inclination, and not having any other generating principle than the pressure, it is clear that it acts when the velocity which generates itself is less or equal to that which was before generated by the inclined plane. Now I repeat, therefore, that the water as it strikes the bottom presses the lower films which run, spread out upon it, by which the pressure is communicated from above downwards. I agree with what Manfredi says, that "all the lower strata of water may be regarded as so many bottoms, or actual planes, with regard to the upper planes which run upon them. Hence these fluid planes are sensible of the same pressure of running water which they would sustain if it were stationary at an equal height." To me it appears an incontestable truth that water which presses the bottom should press all that portion by which the pressure is communicated, otherwise if it does not press all that which forms the middle, it will never arrive at the bottom of it, which is contrary to all experience. If this bottom be of a curved form, concave towards the water, the pressure will have the action of a centrifugal force, the which conspiring with the former, will increase the momentum, and thereby its energy and velocity.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

Jan. 10.—CHARLES FOWLER, Esq., V.P., in the Chair.

Many presents were announced. Among them were drawings from Mr. B. Perry, of the Town Hall of Morpeth, supposed to be by Vanbrugh, and a work on church building by M. de Lassaulx of Coblentz.

Mr. LAYARD, the explorer of Nineveh, was then introduced by Mr. Tite, and at the request of the Institute, made some remarks on the ruins of that city. Of the external architecture, or of the date of the ruins, he could say little, as hardly a fragment remained to guide the judgment, though no doubt of their great antiquity could be entertained. One proof he could give was, that though the earliest ruins were buried in the soil, graves had been dug in these by a people who lived 700 years before the common era. He was inclined to believe that some of these buildings might be three thousand years old. The rooms were covered with marble slabs, sculptured in low relief, like those in the British Museum, and they were joined together by double dovetails of iron, and the doorways were flanked by tall winged figures, higher than the side slabs. The figures were all marked with blood, as if it had been thrown against them, and left to trickle. The walls which back the slabs are of sun-dried bricks, and, where they show above the slabs, are plastered over and painted. Such beams as remain are found to be of mulberry. How the slabs have been preserved is a matter of mystery, but is perhaps to be explained by their lying under the crumbled remains of the bricks, which have returned to earth. Mr. Layard noticed that the buildings were provided with a system of sewage, a drain running from each room to a main sewer. In a small chamber which he had discovered among the ruins, he had seen vaulting of bricks regularly arched. The date of the destruction of Nineveh was 700 years B.C., while the bas-reliefs belong to earlier dates. In many cases the slabs have been used before; one slab was found with the sculptured face turned to the wall, and the back re-worked.

Mr. BONOMI observed that in Egypt the cramps were of wood, and he thought it extraordinary that at Nineveh they should be of iron.

Mr. DONALDSON remarked that those of the Parthenon were of iron, and proceeded to offer his tribute of thanks to Mr. Layard for his communications. He thought that gentleman the more deserving of praise, as so much of what he had done was by his own labour and expense, and yet he had successfully competed with the explorers sent out by the French government. Mr. Donaldson wished to inquire whether the external face of the sun dried bricks were covered with plaster to keep out the wet.

Mr. LAYARD had not observed this. The internal face was partly coloured and enamelled, and decorated with human figures and other ornaments. As to the vaulted chamber of which he had spoken, it was covered with an arch of 12 or 14 feet diameter, very nearly a semi-arch. As to the sewers, they were not arched.

Mr. Pʟ̈ᴀɴsᴏɴ, in correction of a statement at a former meeting, said the new sewers at Hamburgh were not oval, but egg-shaped.

Mr. Pᴏʏɴᴛᴇʀ read a paper on "*Leather Hangings*," illustrated by a number of specimens sent by Mr. Pratt.—The author mentioned examples of leather embossing among the Egyptians, and in the middle ages. and also of its extensive use in the sixteenth and seventeenth centuries, after its revival. The leather used was fine, and was either embossed or simply painted. It was chiefly brought into this country from Flanders and France, and there did not seem to have been any manufactory of it here. Some thought that the process had been first revived either at Venice or in Spain, but this is still matter of doubt, though at Venice embossed leather hangings were in general use in the seventeenth century. The first stage in the process was to join the skins, and then to silver the whole surface. Parts to have the appearance of gold were varnished with coloured varnish. After silvering, the leather was stamped with cut blocks under a press. The borders and more delicate work were executed with metal tools, like those of bookbinders. What is called the Titian Gallery, at Blenheim, has paintings on leather, but they are not by Titian. Mr. Poynter exhibited some fine examples, one being Antony and Cleopatra, from a series formerly belonging to the great Lord Clarendon. He recommended such specimens as suitable for museums of mediæval antiquities.

Mr. Cʀᴀᴄᴇ stated that plaster moulds are used at Paris to emboss the leather, and that much flock is worked up to ornament the face.

The Chairman brought to the notice of the meeting the loss they had sustained in the death of two members of the profession. Mr. Kᴀʏ, a member of the Institute was the first whom he should name, one whom they all knew and respected, and who had taken an active part in the establishment of the Institute.—Mr. Lᴏɴsᴅᴀʟᴇ Eʟᴍᴇs was not a member of the Institute, but a most promising architect, whose works at Liverpool reflected the greatest credit upon him. A slight fall in getting out of a carriage was the more immediate cause of death, but he was suffering from disease which would otherwise have carried him off.

INSTITUTION OF CIVIL ENGINEERS.

Jan. 11.—Sir J. Rᴇɴɴɪᴇ, President, in the Chair.

The first meeting of the session was held this evening, when the following papers were read:—

Mr. Fʀᴇᴅᴇʀɪᴄᴋ Rᴀɴsᴏᴍᴇ's "*process for making Artificial Stone.*"

The *modus operandi* appeared to be very simple. Broken pieces of silica (common flint) being subjected for a time to the action of caustic alkali, boiling, under pressure, in a close vessel, formed a transparent silicated solution, which was evaporated to a specific gravity of 1·600 (distilled water being 1·000), and was then intimately mixed with given proportions of well-washed sand, broken granite, or other materials, of different degrees of hardness. The paste thus constituted, after being pressed into moulds, from which the most delicate impressions were readily received, were subjected to a red heat, in a stove or kiln, by which operation the free or uncombined silica of the raw materials united with the excess of alkali existing in the solution, thus forming a semi-vitreous compound, and rendering the artificial stone perfectly insoluble. This production must evidently be adaptable to a comprehensive range of objects for decorative art, and for architectural purposes; busts, vases, flooring tiles, steps, balustrades, mouldings, capitals, shafts, and bases of columns, &c., even grinding stones and whetstones for scythes, have been made; and, in fact, from the beauty and variety of the specimens exhibited, there would appear to be a vast field opening for such a production. It was stated to be already extensively manufactured at Ipswich, and it was allowed to admit of extensive application where elaborately carved stone would be too expensive.

Mr. Rɪᴄʜᴍᴏɴᴅ, of Bow, exhibited and explained "*an Engine Counter*," manufactured by him on an improved principle. The counters in ordinary use were described as either somewhat inefficient machines, liable to error, or of too expensive construction to be generally employed. This counter differed from others chiefly in its simplicity and its accuracy, whilst, at the same time, its low price of 7*l.* brought it within the reach of every one. With this machine the number of strokes made by the engine or other machine could be read off at one view without calculation. The leading or unit hand traversed the entire circumference of the large dial, and those of the three small dials revolved in the same direction. The first motion was described as being given by a sliding bar and fixed spring, instead of by a double pallet, so that the first wheel could not be thrown more than one tooth by one stroke of the engine. The hands were all moved by a train of wheels and pinions, without skip-wheels, so that the motion was regular and progressive. These were admitted to be advantages, and in the discussion upon the machine its merits appeared to be shown very decidedly.

Jan. 18.—Sir J. Rᴇɴɴɪᴇ, President, in the Chair.

The annual general meeting of the Institution was held this evening, when the following gentlemen were elected to form the council for the ensuing year:—

President—Joshua Field.

Vice Presidents—W. Cubitt, J. M. Rendel, J. Simpson, and R. Stephenson, M.P.

Members—J. F. Bateman, G. P. Bidder, I. K. Brunel, J. Cubitt, J. Locke, M.P., J. Miller, W. C. Mylne, T. Sopwith, J. R. M'Clean, and C. May.

Associates of Council—J. Clutton, and T. H. Wyatt.

The report of the council continues to be very encouraging, and shows that the progress of the society is steadily good.

Telford medals were presented to Messrs. Jackson, Richardson, Murray, Glynn, and Frodsham, and to the two former gentlemen council premiums of books were added. Telford premiums of books were also awarded to Messrs. Elliott, Heppel, Shears, and Masters, for the communications made during the past session.

Memoirs were given of the deceased members and associates, Messrs. Thom, Giles, Lipkins, Mushet, Reynolds, Holtzapffel, Evans, Watkins, and Ball. The career of several of these gentlemen had been so varied, and possessed such points of interest, that the memoirs were necessarily extended beyond their usual length. The report noticed the increased attendance of members and visitors as evidence of its advancing career, and of the interest felt for the science of civil engineering. A pressing appeal was made to members of all classes to contribute papers, to induce animated discussions, which are the distinctive feature of the meetings of the society. The principal events of the past session were touched upon, and several private matters relative to the internal management of the Institution were fully discussed. The council then explained the changed form of the balloting papers, necessitated by the new bye-laws, and the retirement of Sir John Rennie from the post of president, which he had filled with such credit to himself and benefit to the society for the last three years. In conclusion, the report said, "Let the civil engineers remember that 'union is strength;' and that, if they are true to each other, and use the Institution as the common centre and bond of unity, they may set at nought all efforts to dislodge the civil engineers of England from the proud eminence where their talents, their practical skill, and their probity have placed them."

Before leaving the chair, Sir J. Rᴇɴɴɪᴇ, president, addressed the meeting on the selection of the president, and impressed upon them the claims of Mr. Field; not only as one of the founders of the Institution, and who had filled for many years all positions in the society, nor because he was universally respected and esteemed as an upright, honourable, kind-hearted man, but chiefly on account of his acknowledged celebrity as a mechanical engineer, particularly in that most important department—steam navigation; and, because his election would unite more firmly the two branches of the profession, which, to ensure general prosperity, must ever go hand in hand, as they had hitherto done in the Institution, in spite of all attempts to make it appear otherwise. He then reviewed the position of the Institution during his presidentship, offering his best thanks to the vice-presidents and the members of council, and to the secretary, for the support and assistance afforded him; and then examined, with much candour, the relative positions of the civil engineers, and of the government boards and commissions, which had appeared to clash more than was desirable. This he showed not to rise from any of the acts of the civil engineers, who had ever been ready to afford their best assistance to the government in any capacity; and further, that it would be the interest of the government to take advantage of the talent, energy, and practical skill of the civil engineers, by whom they had ever been well served, rather than incur the hazard and the expense of forming a corps that would require more time for educating than could be afforded in these active times, when even hesitation was perdition.

This address was responded to very warmly by the meeting; and a vote of thanks to Sir John Rennie was received with cheers. Thanks were also voted to the council and the secretary of the Institution for their services.

SOCIETY OF ARTS, LONDON.

Dec. 15.—P. Lᴇ Nᴇᴠᴇ Fᴏsᴛᴇʀ, Esq., in the Chair.

The Secretary read a paper, by Mr. A. G. Fɪɴᴅʟᴀʏ, M.R.G.S., "*On the various descriptions of Lighthouses, Beacons, and Light-vessels, their Construction, and the methods of Illumination employed therein.*"

Mr. Fɪɴᴅʟᴀʏ commenced his paper by alluding to the vast importance to a maritime nation like England of having a durable and efficient mode of constructing and illuminating lighthouses, light-vessels, &c., and proceeded to point out the general uses of lighthouses. The oldest structure upon record is the celebrated Pharos of Alexandria, which served as a guide to ancient mariners during a period of nearly 1,600 years. Pliny says, "It was square, of white stone, and consisting of many stories, and diminished upwards till it attained the height of 547 feet." The most ancient structure known to exist in this country is the Roman pharos at Dover castle, and this would still answer its intended purpose, after a lapse of 18 centuries. The celebrated Cordouan Tower, in the Bay of Biscay, is another instance of stability, having been built in 1611. The Eddystone lighthouse has attracted more of the attention of the public than perhaps any other. The first of these edifices was of wood, and built by Mr. Winstanley in the years 1696-8; but, owing to the sea washing over the lantern, it was subsequently raised to a height of 120 feet. In November, 1703, the entire structure was washed away, and in 1706 sanction was obtained for its being rebuilt, which was accordingly done by Rudyerd, but which was destroyed by fire in 1755. The present tower, one of the artificial wonders of England, and built by Smeaton, is 100 feet high, and has given good proof of its capability of resisting the force of the waves. The Bell Rock lighthouse is a

similar structure to the Eddystone; it was built by Stevenson at a cost of £60,000. The most recent erection of this description is on the Skerryvore rock, which cost £90,700.

The author next alluded to the difficulty of constructing permanent light-houses in exposed situations, and the advantages of them over floating lights, as well as the much smaller annual expenditure required to maintain an efficient light. The first floating light was the well known Nore light-vessel, moored in 1734. In order to insure stability in a lighthouse, Mr. Findlay stated that it is necessary that the structure should be capable of affording resistance to a pressure of not less than 6,000 lb. to each square foot of surface exposed to the action of waves. This assertion was founded on experiments made by Mr. Alan Stevenson, who ascertained and registered the force of the waves at the Skerryvore rock, on March 25th, 1845, during a westerly gale, when it was found to be 6083 lb. per square foot; this, the greatest force hitherto registered, was cited with many others. He next proceeded to point out the inapplicability of iron to the construction of lighthouses where the metal was immersed in the sea water, which has the effect of reducing it to a body similar in its chemical properties to black-lead; and instanced the effects produced on a cannon-ball taken from the *Mary Rose*, after having been sunk off Spithead for a period of 150 years: the iron shot upon being exposed to the air gradually became red hot, and then fell into a red powder resembling burnt clay.—The author next described the methods which have been suggested for overcoming the difficulty of exposing large surfaces to the action of the force of the waves, and also for obtaining a firmer foundation on a sand, and especially Mr. Alexander Mitchell's screw-pile lighthouse erected on the Maplin Sand, and Dr. Potts's method of driving piles by atmospheric pressure, as applied at the South Calliper beacon on the Goodwin sands, in 1847, and to other beacons on various shoals at the mouth of the Thames, as on the Blyth sand, and on the shingles in the Prince's channel. Another plan for the erection of lighthouses has been carried into effect at the Point of Ayr by Mr. Walker; it consists in constructing hollow cylinders, which are filled with concrete and then sunk, and from them the piles rise. Capt. Sir S. Brown has also proposed a plan for the erection of lighthouses in deep water upon bronze standards, and a modification of his plan was adopted by Captain Bullock. The author further alluded to Mr. Bush's Light of all Nations, and to Mr. A. Gordon's iron lighthouses at Jamaica and the Bermudas, in which the cases are filled with a solid mass of concrete; and alluded to the fact that Rennie had proposed iron for this purpose as early as the year 1805 for the Bell Rock.

Having thus shown the different methods employed in the construction and erection of lighthouses, Mr. Findlay proceeds to remark on the various plans of illumination which have been employed: of these the earliest was the coal fire and the Cordouan billets of oak. In 1752 the South Foreland lighthouse, previously illuminated with an open coal fire, was covered with a lantern with large sash windows, and the fire was kept bright by means of large bellows; the lantern was subsequently removed, and afterwards, at the commencement of the present century, fifteen large lenses with separate lamps were placed in it. In 1790, the only exception to the coal fire was the Eddystone lighthouse, which had a chandelier with 24 wax candles, and the Liverpool lighthouses with oil lamps and rude parabolic reflectors. An interesting historical fact was then mentioned—viz., that parabolic reflectors were used at the Liverpool lighthouses (built in 1763), as Mr. W. Hutchinson, in his "Practical Seamanship," published that year, describes the apparatus then in use—the larger reflectors of wood lined with small pieces of looking-glass, the smaller of polished tin: this was the more curious, as it had been claimed by the French for M. Teulere in 1783, and first used in Scotland in 1786. The parabolic reflectors, of which some beautiful specimens were shown to the meeting, are now constructed upon the formula of the celebrated Captain Huddart. Having explained the catoptric or reflecting principle of illumination, which received so great an improvement in the invention of the Argand lamp in 1780 or 85, several other lights were exhibited and described—viz., the Drummond light, the voltaic light, and the causes of their inapplicability. The present mode of lighting is from lamps constructed on a modification of the Argand principle. A first-order pneumatic lamp with four concentric wicks, showing a most powerful light, was exhibited. The dioptric principle, in which the rays of light emanate from a central lamp, and are controlled and directed by a series of lenses placed before and around it, next occupied attention. The author claims the priority of its suggestion for an optician in London, as mentioned by Smeaton, who proposed, in 1759, to grind the panes of the Eddystone lighthouse into a sphere of 15 feet diameter. The present form of lens, generally known as Fresnel's, was first suggested by the celebrated Buffon, to whom it is probable the catoptric system owes its origin. Sir David Brewster, in 1811, showed the practicability of constructing a lens of separate pieces, and this was first used in France by Fresnel, and has since become universal in French lighthouses. A comparative view of the catoptric and dioptric systems is afforded by the fixed lights of the South Foreland, the higher being from the dioptric principle and the lower from Huddart's reflectors, which to a distant observer appear equally bright—the only test of their efficiency. The cata-dioptric principle was illustrated by a beautiful fourth-order apparatus, lent by Messrs. Wilkins, in which, above and below the light, a system of totally reflecting prismatic zones is arranged, the suggestion of Mr. A. Stevenson. Mr. Alexander Gordon's cata-dioptric system, a union of the reflector and refractor, was also described.—Some particulars respecting the power of light in penetrating mist were also brought forward. During fogs the attendants of light vessels sound a bell at intervals, or, as now used by the Trinity Board, a Chinese gong. Instead of this, Lieut. Sheringham, R.N., proposed, in 1842, to use a whistle worked by bellows, and Mr. Gordon proposed to place the whistle in the focus of a parabolic reflector, to direct the sound. Mr. Findlay concluded his paper by suggesting the use of Mowbray's chemical whistle, which was exhibited and described.

ROYAL SCOTTISH SOCIETY OF ARTS.

Jan. 10.—GEORGE BUCHANAN, Esq., F.R.S.E., President, in the Chair.

The following communications were made:—

1. *Description with Drawings of a Portable Cofferdam, adapted specially for the use of Harbour and other Marine Works in exposed situations.* By THOMAS STEVENSON, Esq., C.E.

This cofferdam was used at Hynish harbour works, Argyllshire, for excavating rock which was seldom left dry by the tide, and was covered with two feet of sand. It was found impossible to form a common cofferdam, owing to the shallowness of the sand, which could not afford any support to piles, and to the violence of the sea, which would in a single tide either wholly break it up or render it leaky. The cofferdam adopted being portable, was moved from one compartment of the cutting, when finished, to another. It consisted of two double frames of timber, each complete in itself, being bound together with iron rods, forming a dam about 10 feet by 14, and 3 feet high. One of these double frames (being somewhat less than the other) was placed inside of the larger, so as to admit two piles being driven between them. In this way the piles could, from the depth of the frames, be driven perfectly straight, and were also quite independent of support from the sand. As each compartment of the excavation was completed, and before the dam was removed, one row of piles was driven down to the bottom of the pit and left standing, so as to be a guide for again superimposing the frames over them, and in this way it was impossible for any of the rock to escape being removed. The peculiar advantages are its portability—its ready adaptation to a sloping or to an irregular bottom—the ease and certainty with which the partitions between each section of the rock were removed, and the double-framed walings that supported and directed the driving of the piles. Whenever excavations require to be made in a rocky beach covered by a stratum of sand, however thin, this form of dam may be used, as there is no kind of lateral supports such as shore wanted, the structure containing within itself the elements necessary for its stability. It possesses, indeed, the properties of a caisson, with the additional advantage of accommodating itself to an irregular bottom.

2. *Description of a Cast-iron Skew Bridge, of two arches—of* 100 *feet span each—now being erected to carry the Leeds, Dewsbury, and Manchester Railway, over the River Calder at Ravenswharfe, near Dewsbury.* By THOMAS GRAINGER, Esq., C.E.

This bridge is a skew at an angle of 56 deg., and consists of two arches of 100 feet span, with a pier about the centre of the river; each arch is formed with six cast-iron segmental ribs, having a rise of 12 feet,—each rib is cast in five pieces, having flanges or lugs at the joinings, and bolted together with 2-inch bolts; the section of the ribs at the abutments is 3 feet deep, the web 2½ inches thick, the top and bottom moulding or flanges 8 inches by 3 inches, presenting an area of 123 inches; the section at the crown is 2 ft. 9 in. deep, and otherwise the same as at the abutments, and presents an area of 115½ inches. The spandrils are cast along with the ribs—the joints being formed at the uprights instead of at the intermediate spaces, as shown on the model. The ribs have dovetailed sockets cast upon them to receive the cast-iron braces which are keyed into them; these braces, 10 in number, stretch across the bridge at right angles to the ribs; there are also 8 wrought-iron tie-rods, 2 inches diameter, placed parallel to the line of the abutments, to connect the whole structure together. The ribs abut against and are keyed into massive iron bed-plates sunk into the stone-work of the abutments. The roadway is supported by transverse timber beams 12 inches by 9 inches, bolted to the top of the spandrils at intervals of 3 feet from centre to centre; the planking is 3 inches thick, and is laid diagonally across these beams, and spiked to them with 6-inch spikes; and over the planking a coating of asphalte is to be laid. The outside ribs are surmounted by a cast-iron cornice to correspond with the masonry, and having a cast-iron railing on the top. The estimated weight of the cast-iron in the bridge is 603 tons 4 cwt., and the expense of fitting up the iron and timber work has been contracted for at 8,598*l.*

3. *Observations on the means by which Time may be communicated by Signal Balls from one Station to another.* By JOHN ADIE, Esq., F.R.S.E.

The author of this paper remarked, that the distance of the Nelson Monument from Leith, and more so from Leith Roads, would allow a time-ball placed on the Monument to be distinctly seen only in very clear weather, which is confined to a limited number of days, rendering it of little use to the shipping in the Frith of Forth. He next described a method by which the ball on the Monument, and one at Leith, might be dropped at the same second of time, by a person in charge at the Royal Observatory, Calton Hill. This he proposed to do by making use of the great force induced on artificial iron magnets, the wires surrounding these magnets being brought into contact with the poles of a galvanic battery placed in the Observatory, and em-

ploying this force to draw bolts or catches to free the balls and allow them to drop; a number of magnets in communication will develop their forces at distant stations at the same moment, and allow balls at several stations to indicate the same second.

4. *Description of a Safety-Wheel Ring-Revolver, to prevent Wheels of Carriages from flying off the Axles.* By Rev. GRAHAM MITCHELL, A.M.

The object of this invention is to prevent disasters, by rendering it impossible for any wheel flying off the axle, whether from tear and wear, or concussion. Independently of all former contrivances of security for human life, there is here superadded a brass or iron ring attached to the wheel behind the bush, which apart revolves along with the large wheel itself round a nitch cut in the axle of the carriage, and which is designed to act as a preventive against a wheel ever flying off, whatever be the velocity of revolution.

INSTITUTION OF CIVIL ENGINEERS OF IRELAND.

Dec. 14.—Col. H. D. JONES, President, in the Chair.

The following papers were read:—

"*Description of a Clock with a Registering Machine attached.*" By Mr. SHARP.—An ordinary clock was exhibited, with the addition of a certain number of projecting pins on the dial; the interval between every two pins expressed a certain portion of time, being that which elapsed while the hour hand of the clock, in its ordinary motion, passed from one pin to another; a lever was attached to the back of the dial, by means of which the hour hand could be pushed in at any time against the face of the dial, and, by coming in contact with one of the projecting pins immediately under it, push it in also, and the pin so pushed in would register, within but a few minutes, the exact time the hand was brought in contact with the dial. Mr. Sharp explained how, by means of a sufficient number of pins on the dial, very small intervals of time might be registered. This invention he conceived could be used for all the purposes of a noctuary, and might, by means of an additional mechanical contrivance, be made to register the times of the arrival and departure of the trains, by means of the trains themselves. He also explained how the movement of the clock was not in the least injured by this addition, and that this means of registering might be also applied to clocks already constructed.

"*A short account of the Fall during a violent storm, of part of a Roof in progress of erection over the Dublin terminus of the Midland Great Western Railway.*" By Mr. HEMANS.—The total length of the roof of this building is 475 feet, and the width 120 feet, divided into two spans of 60 feet each, the roof resting on walls at either side, and on columns in the centre. The centre columns are 62 ft. 6 in. apart, and are connected by flat arches and gutter-plates. The whole structure, with the exception of the columns, gutter-plates, tie-washers, and sockets, is composed of rolled iron. The principal, which are the only rafters, are 38 in number to each half-roof, and are 12 ft. 6 in. apart. They are formed of what are called "deck beams." The cover of the roof is of corrugated galvanised iron, and connected by bolts and rivets similarly galvanised, and provision is made for expansion and contraction. Twenty-five of the principals were erected on each side, and the whole centre line of columns and arches complete, when the storm, the cause of the accident, began. The principals not being connected together by temporary diagonal braces (none would be required when the corrugated covering was fixed), were exposed to the powerful action of the gale in the direction in which no temporary provision had been made to withstand lateral pressure; and the consequence was, as might naturally be expected, that the greater portion of them were blown down one over the other, like a pack of cards; and the whole of them had snapped their sockets.

Several members expressed their satisfaction at Mr. Hemans having placed on record this failure through inattention to the necessary precautions in the execution, which would prove an useful lesson.

"*An account of the removal of a Mill at the Cutts, near Coleraine.*" By Col. H. D. JONES, President.—The paper was accompanied by several drawings explanatory of the subject, and detailed the mode adopted for the removal of a large mill, the height of which, to the eaves, was 65 feet, and the walls were of proportionate thickness, being three feet at the level of the ground story. The execution of the works in connection with the drainage of Lough Neagh, rendered the removal of this mill necessary, and the use of gunpowder was considered the most economical means of effecting this object; but the contiguity of the mill to several houses by the roadside rendered it necessary to guard against accident, by limiting the charge of powder. A detailed account was given of the quantity of powder used, the mode of applying the charges, and the effect produced, and very satisfactorily proved the economy of the measure. This work was conducted under the superintendence of Mr. C. S. Ottley, the district engineer for Lough Neagh drainage.—The President stated that he had used gunpowder with much advantage, both as regarded effect and economy, in the removal of large buildings, but especially in the removal of a large storehouse at Flushans.

Mr. M'MAHON stated the great advantage of adopting the plan which had been so successfully tried in the present instance.

Mr. CLARENDON described the mode by which the high dock wall had been removed at the site of the Dublin and Drogheda railway terminus in Amiens-street, which had been effected expeditiously and economically, and without the use of gunpowder.

Mr. DEAN called the attention of the Institution to the inefficient state of the sewerage of Dublin.

HINTS TO PLANTERS.

A correspondent of the *Gardeners' Chronicle* says, "In rambling through the New Forest, I have been much struck by observing how much the beauty of natural woods depends upon the open glades, or intervals bare of trees, which there so frequently occur, and have often wondered why the landscape gardener so seldom imitates nature in this respect. In the disposition of the open and the wooded spots, it may be observed that nature commonly fills up the valleys with wood, and leaves most of the brows and eminences bare, and in an undulating country, nothing is more pleasing to the eye than thus to see the woods creeping up the hollows and gradually feathering off, and disappearing as they approach the summits of the hills, which rise bare of trees above them. The landscape gardener almost invariably does the reverse. He commonly plants all the eminences (probably from the notion of making a more conspicuous show at a distance), leaving his vacant spaces in the valleys and lower grounds. By this means (putting appearance out of the question) he subjects his trees to the double disadvantage of a more exposed situation, and a shallower soil; consequently his trees grow incomparably slower than they would do in the deeper soil and more sheltered situation of the lower grounds. Trees differ so much in the soil and situation suitable to the different kinds, that it is of the utmost consequence to the planter that the one should be adapted to the other; and if planters could be induced to look after these things themselves, instead of entrusting them to the nurseryman, one would not so often see plantations filled with such worthless trees as beech and sycamore, where more valuable sorts, such as elm, ash, and chesnut, would flourish equally well. With this view, I have thrown together a few observations on the sorts of trees commonly planted. The larch would, no doubt, be the most valuable tree that can be planted, were it not unfortunately subject to that peculiar disease, called the heart-rot, which, I believe, is not known to affect any other kind of tree. After growing vigorously for twenty or more years, the heart of the tree up to a considerable height becomes entirely rotten, without any apparent external decay. The cause of this singular disease is as yet unknown. I am myself inclined to believe that it usually arises from too great dryness in the soil. In Switzerland the native habitat of the larch is in situations abounding in moisture, viz., the sides of slaty and granitic mountains; and the plantations in which, in this kingdom, it seems to flourish best, are in similar situations in Scotland and Wales. In England it has principally been planted on dry sandy heaths—a situation which affords the greatest contrast to its native habitat, and which the prevalence of the heart-rot shows to be uncongenial to its nature. In point of beauty little can be said in favour of the larch; it never forms a handsome mass of foliage; and the spiky outline even of the oldest woods always has a poor, unpleasing effect. It must, however, be acknowledged that a single tree of larch often has an elegant appearance. The Scotch fir is of so hardy a nature that it will flourish in almost any soil or situation. It is in very bad repute as a timber tree when grown in England, which is a very singular fact, as it is well known that the same species of pine, when grown in the north of Europe and the highlands of Scotland produces that excellent timber known as the red deal. Different causes are assigned for this extraordinary difference in the timber grown in England and grown abroad. Some persons suppose that the home and foreign grown fir are different varieties of the same species, one of which always produces hard and the other soft wood; some suppose that the colder climate and slower growth of the Baltic timber is the cause of its superiority; and any one who will take the trouble of counting the number of annual rings in Baltic timber must see that its growth is in general excessively slow; others consider that age alone is wanting to render the timber good, and that if we were to allow English grown fir to attain the age of one or two centuries, as is the case with the Baltic grown, our timber would be equally valuable. That English fir timber does improve as the trees grow older, is a fact well known to timber merchants; and I can instance the roof of the house in which I am now writing, which was framed of English fir, of very large scantling, about forty years ago, and which to all appearance is now as sound as the day it was put up. It must also be observed that the English fir is commonly cut down of small dimensions, and full of sap wood, while most of the sap wood is cut away from the Baltic balks before we get them. But there is still one point, which I have never seen noticed, which, perhaps, may go far to account for the difference of quality. I mean the season in which the timber is felled. It has never yet been ascertained that resinous trees ought to be felled in winter, as is the universal practice in England, and it is not unlikely that the resinous juices with which firs abound in summer may tend to increase the durability of the timber felled in that season. I would strongly impress on those who have the opportunity, how desirable it would be to institute experiments on this point. It is stated, on what appears to be good authority, that both in Norway and the rest of the north of Europe fir trees are always felled in summer. In Switzerland, as in England, the timber of the Scotch fir is reckoned of very little value. As an ornamental tree the Scotch fir is gone much out of fashion, yet when allowed to attain a sufficient age its rounded top and red-coloured bark and contorted

limbs produce a grand and picturesque effect in the landscape which scarcely any kind of tree can surpass. The spruce fir delights in a light soil and a very moist situation. In such situations, when not crowded by other trees, so as to have plenty of light, it forms a beautiful mass of thick foliage, towering to a great height. It is quite useless to plant it in very dry, shallow, or rocky soils. I have seen young spruce firs flourishing in stiff clay, though I believe ultimately such soils do not suit it. It often deceives the planter by growing vigorously for 15 or 20 years, and afterwards becoming stunted, exhibiting nothing but a few ragged leaves on the ends of the branches, being then one of the most unsightly objects in nature. It is singular that a native of Norway should seem in our climate not patient of wind or frost. It affords a soft wood, useful for many purposes, but always very full of knots, unless it has either been severely pruned, or grown in such close woods as to lose its side branches by natural process of decay from want of light. The silver fir flourishes in stiff wet clays, and throws up its tall head quite perpendicularly, even in the most exposed situations, apparently uninjured by the utmost fury of the wind. It is a tree which the landscape painter never thinks of introducing in a picture; yet it is not without a peculiar beauty of its own, and often produces a grand effect, either in the stiff formal avenue, or when seen towering above other trees. Its timber is much like that of the spruce fir, but of rather better quality."

OBITUARY.

MR. HARVEY LONSDALE ELMES.

It is scarcely surprising that the death of Mr. Harvey Lonsdale Elmes should have produced such a strong feeling of regret, as has been manifested at Liverpool by so many of its leading men, for the death of a man of genius in the early prime of life is well calculated to awaken sympathy, and most in a town adorned by noble monuments of his taste, in his devotion to which he hastened the progress of disease and death. Our readers will think that such an artist deserves at our hands a more lengthened notice than he has yet received, for there is always a sentiment of personal interest, which attaches to the career of one so young in life, and so rich in endowments. Harvey Lonsdale Elmes was born in 1813, we believe in London, and was the son of James Elmes, Esq., the surveyor of the Port of London, and himself distinguished as a large contributor to architectural literature. With him he was brought up, and the natural abilities he early showed were fostered by association with the many men of genius with whom his father was intimate, or in connexion. Young Mr. Elmes's talents were decidedly of an artistic tendency, but chiefly directed towards architecture and music, and he showed a peculiar delicacy of mind, stimulated perhaps by delicacy of physical organization. His zeal was ardent, and his powers of application great, while his love of fame gave him the stimulus for great exertion. With such qualifications Mr. Elmes began under his father's care his architectural studies, which he afterwards pursued under Mr. Elger of Bedford, and Mr. H. E. Goodridge of Bath. He was likewise employed by Mr. John Elger, a builder in London, until he acquired the charge of works of his own.—In 1836 or 1837, when Mr. Elmes was in his twenty-fourth year, the Liverpool Committee advertised for designs for St. George's Hall, which was then intended to be a separate building. The advertisement was put into Mr. Elmes's hands by a friend, as being worthy of his notice, and he took it to the late Haydon, one of the earliest friends of his youth, to ask his advice whether he should compete, as Haydon knew many persons at Liverpool, having received commissions for pictures from the Blind School and other institutions. "By all means, my dear boy," said Haydon; "they are noble fellows at Liverpool. Send in a design, and mind, let it combine grandeur with simplicity. None of your broken-up and frittered abortions, but something grand." Following this exhortation Mr. Elmes set to work, and when he had made his first sketch, took it to a friend's house, where a trifling incident gave him the augury of success, for a little boy looking at the drawing very gravely, threw it down, saying emphatically, "Very good, very good, indeed; it's worth five hundred pounds." When the design was sent in, it was successful against eighty-five competitors, and Mr. Elmes received the premium of five hundred pounds. Afterwards he carried off in other competitions the premiums for the Assize Courts at Liverpool, and for the Collegiate Institution there. He was likewise the winner in a competition for the Assize Courts and St. George's Hall combined. These several victories gave Mr. Elmes the prestige of a reputation, which his own attainments were calculated to support. Entered upon a new career, he now devoted himself zealously to carry out in detail the several designs on which he was engaged, and his professional business greatly increased. He obtained the prize for the County Lunatic Asylum, at West Derby, in Lancashire, and was employed in erecting mansions for Mr. George Hall Lawrence, late Mayor of Liverpool, for Mr. Hardman Earle, and Mr. Hugh Horaby.

These labours, borne by a weak frame, at length brought their own end. In the early part of last summer Mr. Elmes showed such strong symptoms of consumption that change of climate became necessary. He wished to go to Italy to study the monuments of his art in that country, but his health was so much shaken that Dr. Chambers urged him to go immediately to the West Indies, and travel from island to island. Before he left he made arrang ements with Mr. Cockerell to superintend the architectural detail of St. George's Hall, for which he had finished the whole of the plans.

In 1841 Mr. Elmes had married the daughter of C. D. W. Terry, Esq., and accompanied by that lady he set out on that journey from which he was never to return, for he died at Spanish Town, Jamaica, on the 26th of November last, aged 34, leaving one child.

Thus he was cut off in the prime of his life, and when only beginning to enjoy the honours and rewards due to his exertions. When Prince Albert visited Liverpool, he was so delighted with St. George's Hall that he sent a gold medal to Mr. Elmes, and the architect only awaited the completion of his work to receive plaudits on every hand. As it is, those honours must be paid to his tomb; and indeed the Town Council of Liverpool on the announcement of his death, gave a public expression of their strong feelings of regret for what they felt to be a heavy loss.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM DECEMBER 30, TO JANUARY 20, 1848.

Six Months allowed for Enrolment, unless otherwise expressed.

Thomas Hancock, of Stoke Newington, Middlesex, and Reuben Phillips, of Islington, Middlesex, chemist, for "Improvements in the treating or manufacture of gutta percha, or any of the varieties of caoutchouc."—Sealed December 30.

Felix Edwards Pratt, of Fenton Potteries, Stafford, earthenware manufacturer, for "Improvements in manufacturing articles composed of earthenware or china."—Dec. 31.

Mary Jenkins, of Atton, Warwick, widow, for "Improvements in the manufacture of pins, hooks, eyes, and other fastenings."—Dec. 31.

Edward Humphrys, of Holland-street, Surrey, engineer, for "certain Improvements in steam engines, and in engines or apparatus for raising, exhausting, and forcing liquids."—January 4.

William Froude, of Darlington, Devon, civil-engineer, for "Improvements in the valves used in closing the tubes of atmospheric railways."—January 5.

Read Holiday, of Huddersfield, manufacturing chemist, for "Improvements in lamps."—January 5.

Charles De Bergue, of Arthur-street west, city, engineer, for "Improvements in carriages used on railways."—January 5.

Alexander Robertson Arrott, manager of the Union-place Glass Works, St. Helens, Lancaster, for "Improvements in manufacturing common salt."—January 5.

Charles Lambert, of Two-Mile Hill, St. George's, near Bristol, pen-maker, for "certain Improvements in machinery for making nails."—January 5.

Josiah George Jennings, of Great Charlotte-street, Blackfriars-road, for "Improvements in cocks or taps for drawing off liquids and gases."—January 5.

George Bell, of the city of Dublin, merchant, for "certain Improvements in the arrangement of wheels and axles for steam and other carriages, which facilitate travelling on railways and common roads, parts of which improvements are applicable to other machinery."—January 7.

James Montgomery, of Salisbury-street, Middlesex, for "certain Improvements in pianofortes and other similar finger-keyed instruments." (Being a communication.)—January 11.

Alfred Augustus de Reginald Hely, of No. 11, Cannon-row, Westminster, and Joseph Emmett Norton, of Saint Mary-le-Strand-place, Kent-road, Surrey, wine-merchant, for "certain Improvements in bottles or vessels for containing liquids, and in the mode of and machinery or apparatus for filling and stopping the same."—January 11.

Gardner Stow, late of King-street, Cheapside, but now of New York, gentleman, for "Improvements in apparatus for propelling ships and other vessels."—January 11.

William Thorold, of Norwich, engineer, for "Improvements in turn-tables."—January 13.

Robert William, M.A., Greenock, for "Improvements in certain kinds of rotatory engines worked by steam or other elastic fluids, part of which improvements are applicable to rotatory engines worked by water, or by the wind; also, an improvement in safety-valves for steam boilers."—January 13.

Sydney Edwards Morse, of Ampton-place, Gray's-inn-road, for "Improvements in the manufacture of plates or surfaces for printing or embossing."—January 13.

Benjamin Mitchell, of Huntingdonshire, farmer, for "Improvements in the manufacture of manure."—January 13.

Robert Heath, of Heathfield, Manchester, gentleman, for "certain Improvements in the method of applying and working friction brasses to engines and carriages used upon railways."—January 13.

Job Cutler, of Spark Brook, Birmingham, civil engineer, for "certain Improvements in welded iron pipes or tubes to be used as the flues of steam boilers."—January 13.

John Gilmore, Lieutenant in the Royal Navy, for "certain Improvements in ventilating ships and other vessels."—January 17.

Charles Crane, of Stratford, Essex, manufacturing chemist, and James Thomas Jullion, of the same place, analytical chemist, for "Improvements in the manufacture of certain acids and salts, and a new apparatus applicable to the said improvements."—January 18. Four months.

Samuel Cunliffe Lister, of Manningham Hall, in the parish of Bradford, esq., for "Improvements in stopping railway trains and other carriages, and generally where a lifting power or pressure is required."—January 18.

John Hickman, of Birmingham, for "Improvements in the means of constructing and connecting parts of bedsteads, couches, and other articles of furniture to which such improvements may be applicable, and also in the means of attaching knobs or handles to drawers, doors, and other parts of furniture."—January 18.

William Newton, of 66, Chancery-lane, Middlesex, civil engineer, for "Improvements in the manufacture of sugar from the cane." (Being a communication.)—January 18.

John Frederic Bateman, of Manchester, for "certain Improvements in valves or plugs for the passage of water or other fluids."—January 18.

Thomas Robert Sewell, of Carrington, in the parish of Basford, Nottingham, chemist, for "Improvements in preparing flour."—January 18.

Joseph Clinton Robertson, of 166, Fleet-street, London, civil engineer, for "certain Improvements in the manufacture of textile fabrics, stuffs, and tissues, and of certain new products obtained by the aid of such improvements." (A communication.)—January 19.

John Duncan, of Brentwood, Essex, gentleman, for "certain Improvements in tanning of hides."—January 20.

CANDIDUS'S NOTE-BOOK
FASCICULUS LXXIX.

"I must have liberty
Withal, as large a charter as the winds,
To blow on whom I please."

I. There is reason for concluding that the peripteral temples of the Greeks were so planned rather for the sake of architectural dignity and effect, than, as is generally supposed, for that of any particular convenience or advantage. The cella itself being narrow, colonnades along its sides served to give greater importance to the edifice by enlarging its entire bulk, its ends or fronts being increased from tetrastyle to hexastyle, or from hexastyle to octastyle, if the lateral colonnades consisted of only a single range of pillars; or if the columniation was of the kind called dipteral, increasing the width of the fronts by four more columns beneath their pediments: thus, a cella, with a tetrastyle in front of it, would acquire an octastyle portico, by having dipteral colonnades erected along its sides. This last-mentioned mode (the dipteral) certainly does provide a greater sheltered-in space on the sides of the edifice; still, hardly sufficient for any real use of it as an ambulatory—at least, not for a number of persons. Such purpose was far better accomplished by the *pseudo-dipteral* plan, in which the middle row of columns, or those between the external ones and the walls of the cella, were omitted, whereby a clear space was obtained equal to the width of two intercolumns and one column. Yet, if much was thereby gained in point of convenience, not a little was lost in regard to effect and richness of character; and the body of the temple showed as a comparatively diminutive structure, standing within an open though covered colonnaded inclosure. As to the single peripteral, its colonnades must have been more for show than for real service, since they were very ill-calculated for accommodating a multitude of persons. Even in the Parthenon, the clear space between the external columns and the walls of the cella was not more than six feet wide; consequently a mere passage, rather than either an ambulatory or a shelter for a large concourse of people.

II. With regard to the Parthenon, a most extraordinary error occurs in the English edition of Gailhabaud's "Ancient and Modern Architecture" (second series), it being there stated that "its length, measured on the top of the steps, is 114 feet, its width 51 feet;" according to which, the area of the building is not above *one-fourth* of what all other accounts make it, for they make it both twice as long and twice as wide! To puzzle us the more, there is a foot-note calling particular attention to those measurements, from which it would seem that pains had been taken to insure more than usual accuracy, they being there said to be upon the authority of a "recent"— and therefore, it is to be presumed, a more correct—measurement by Mr. Travers. Yet, no notice is taken of the enormous discrepancy between them and the usually-reported dimensions, or of the equal discrepancy from the plan and its scale given in the work itself. The scale being in metres—to which one in English feet should have been added to the plates in the English edition—the contradiction between the text and engraving is not so immediately obvious as it would else be; but, on applying compasses and calculation, we find the length to be 69 metres and the breadth 51, which converted into English measure, give 226 and 101 feet respectively, or double what is stated in the text! Had either the English writer or editor compared the description and plan together, their total want of agreement must have been discovered, which done, Mr. Travers's measurements would perhaps have been discarded as quite untenable. Some as strange or even stranger mistake perplexes us a little further on, where we are told that the external columns are three feet in diameter (or only half what they are usually stated, viz., six feet and a fraction), yet *thirty-four feet four inches* high, which would make their height between eleven and twelve diameters! and how such extraordinary proportions could have escaped notice when the proof was read over is incomprehensible. Neither does error terminate there, since, besides the palpable contradiction in regard to the diameter and height assigned to the columns, the latter measurement and that of the entablature (10·10′) renders the entire height of the order 45 feet; which, though in itself it may be correct, is altogether irreconcileable with the width of the front being only 51 feet, or little more than a square in height,—the proportions not of an octastyle but a tetrastyle, and such as it is impossible to give to the former. Here, then, we have a pretty complication of blunders, and those of the most serious kind, in a publication which ought to be scrupulously accurate in regard to the measurements which it gives of buildings. There is what looks like sufficient pledge for editorial responsibility and carefulness, the title-page assuring us that "the translations are revised by F. Arundale and T. L. Donaldson, Prof. Arch., Univ. Coll., London;" therefore, to those gentlemen may be left the task of accounting for or explaining away the egregious mistakes here pointed out, and which compromise the credit and character of the work to such degree as to demand correction—if in no other way, by cancelling the pages where they occur. Not the least awkward part of the matter is, a detection of the kind naturally excites mistrust as to other articles, where mistakes either of a similar or different kind may have escaped the English *revisors*. In that very article on the Parthenon, one paragraph that ought to have been omitted, was unluckily suffered to remain—namely, that which says: "We give with this notice a splendid specimen of polychromatic architecture of the Parthenon, being a perspective view of the entablature and capitals, restored with the utmost care by Mr. Travers, from traces which he discovered in the monument itself." There is, however, no such plate in the work—at least, not in the English edition, although it would have been particularly acceptable, and far more valuable than all those of such unarchitectural subjects as Cromlechs and Celtic monuments, put together. Of *them*, two or three specimens at the utmost would have sufficed: still better would it have been had they been excluded altogether from a work which, were it to be extended to a hundred volumes, could not possibly illustrate all that is worthy of notice in "Ancient and Modern Architecture."

III. It is not only with regard to the notion of Blore's façade to the Palace being a copy of that of Caserta, that Mr. Sharp and myself differ materially, my opinion of Elmes's "History of Architecture in Great Britain" being so very dissimilar from his, that I think the Editor has very great reason to complain of such a carelessly-executed and inaccurate performance being passed-off upon him under the responsibility of Mr. Elmes's name. While there is a great deal of mere garrulous filling-up anecdote, quite out of place in an historic outline, and out of all proportion to the brevity and rapidity of the record itself, there are not a few omissions, and some of them truly unaccountable ones. Both Kent and his patron, the Earl of Burlington, may be said to be passed over in silence, since they obtain no further notice than the complimentary mention of their names as "two accomplished architects of the Anglo-Palladian school," without a syllable about any of their works—either the "Holkham" of the one, or the "Chiswick" of the other. The name of "Holkham," indeed—and it is the name only—occurs elsewhere, but wrongly, for the credit of that palatial mansion is taken from Kent, and assigned to Brettingham, who merely published the designs of it, with his own name on the title-page. It would seem, then, that "accomplished" architects as they were, Kent and Burlington are not entitled to figure at all in a history which brings forward such a mere nobody as John Yenn. Neither is any mention made of Carr, of York, although he was of considerable repute in his day, and erected many important mansions and other structures in the northern counties. Harrison, of Chester, too, is similarly passed over without being so much as named; and to him may, among others, be added Porden. Besides omissions of that kind, there is, with just here and there an exception, the general and pervading omission of all attempt at satisfactory critical estimate of the architects and buildings that are recorded. So little real substance is there in it, that Mr. Elmes's "History" amounts to very little more than a dry catalogue of names. What is worse, it is not trust-worthy: on the contrary, is so full of obvious mistakes as to excite general mistrust, for nothing is to be depended upon it which the reader cannot verify for himself. The Royal Exchange at Dublin, which "everybody" knows to be by Cooley, whose talent and taste are very happily displayed in it, is erroneously attributed to Chambers. Gandon is misnamed, for he is called *William* instead of James,—a mistake, perhaps, of no very great moment, but which, coming along with so many others, evinces the writer's habitual carelessness. It would, too, have been as well to have stated, that a "Life" of Gandon—such as it is, was published about a twelvemonth ago. Connected with Gandon, there is another mistake, for after he had been spoken of as having edited the two last volumes of the "Vitruvius Britannicus" (viz., the 4th and 5th), we are told that "Colin Campbell published his useful work, the 'Vitruvius Britannicus,' *in four consecutive* volumes, between the years 1715 and 1771"—therefore, the last of them about forty years after his death—"to which, Woolf and Gandon *respectively* added supplementary volumes of equal skill and correctness." This is so ambiguously worded, that it seems to say, each of the two latter editors separately added more than a volume to the original work,

instead of bringing out conjointly two other volumes to accompany the three that had been published by Campbell. When he was mentioning that collection of designs, Mr. Elmes might as well have observed, that it is by no means so complete as it ought to have been; for while it is made to contain several very dull and uninteresting subjects, others are omitted which are either of considerable celebrity or merit,—such as Lord Burlington's Casino, at Chiswick (since altered by Wyatt), and St. George's, Bloomsbury.

IV. In speaking of Wyatt's Pantheon—of which greatly, if not extravagantly, admired structure, it is equally matter of surprise and regret that no engravings were given, either in Gandon's last volume of the "Vitruvius," or in the subsequent work by Richardson,—Mr. Elmes sadly neglects his proper duty as an architectural historian, to gossip very provokingly about Lunardi's balloon, instead of entering into any description of the edifice itself, which he merely calls a "fine work," without particularizing any of its beauties and merits. The only part of it on which he makes any remarks, is that which least of all required notice—namely, the front; it still remaining pretty nearly what it was at first. He speaks, however, of the portico as having been of the Ionic order; and if so, the Doric one, which existed before the building was converted into a bazaar, cannot have been that which Mr. Elmes alludes to, although he does not say as much. In what is said of that front, the term "wings" is not very correctly applied, the whole of it forming only a single general mass, without such subdivision into distinct collateral masses as properly answer to the denomination of "wings," which Mr. Elmes elsewhere applies equally vaguely, as when noticing the "Trinity House," and the "Society of Arts" in the Adelphi. Another instance of his indefiniteness in what ought to be explicit technical phraseology, is his very untechnical mode of describing a recessed portico or loggia, calling it sometimes an "inverse" portico, sometimes a "retrocessed" one, or by some other more fantastical than intelligible epithet.

V. The admiration professed for what is Soane's happiest piece of composition has not extended itself beyond words. We may say of it *laudatur et alget*, since no one has testified his estimation of it by borrowing an idea from it, notwithstanding that similar striking effect and picturesque expression might be obtained without falling into direct imitation. Nay, Mr. Elmes would make out Soane himself to have been there only an imitator,—at least, to have "had in his mind the semicircular porticos of the transepts of St. Paul's," as if, without them, the idea would not have emanated, as no doubt it immediately did, from his studies of the Temple at Tivoli, whose order—an equally beautiful and peculiar example of the Corinthian, that had previously been ignored by all modern architects and all the systematisers of the Five Orders,—was adopted by him at the Bank as a decided novelty, with unimpeachable classical authority for it. Still, though he adopted it, even Soane himself does not appear to have comprehended its character, for it is only at that angle of the Bank that he has exhibited it entire, having in the other parts of the building employed the columns only, without the entablature which belongs to them, not only in conformity with the original example, but in conformity with the laws of æsthetic design. By suppressing—as if such change was of no moment at all—the rich embossed frieze, which is absolutely necessary for keeping up harmony and perfect agreement in the *ensemble* of the order, he converted the entablature altogether into one which contrasts rather than at all agrees with the columns themselves. Their fluted shafts become too rich, and their capitals look too heavy, in comparison with the emasculated entablature. The energy of expression, as well as the degree of decoration assumed for the columns, stops short with them, instead of being carried on consistently, and extended to the horizontal division of the order, where, if anything, increase rather than diminution of decoration is requisite, since otherwise, a most disagreeable falling-off takes place: *amphora cœpit institui,—urceus exit.* If decoration is to be moderated at all, it should at least be done consistently, and so as not to throw one part out of keeping with another; the doing which—and it is by no means uncommon—betrays either downright ignorance, or wilful and most unpardonable disregard of both precedent and principle. What is not least of all extraordinary is, that those who are gifted with such very microscopic vision as to be struck by the profile of a mere moulding in a cornice, or some equally minute detail, take no notice of such wholesale omissions as the suppression of sculpture on a frieze amounts to. In some portions of the Bank the frieze is not, indeed, left entirely blank, it being ornamented with a Vitruvian fret; which, however, has a tame and insipid look in comparison with the boldness of the capitals. If deviation from the original there was to be at all, it would not have been amiss, perhaps, to increase the cornice, and also give it something of richness; thereby rendering the entablature equivalent in force of expression to that of the columns.

VI. With regard to that particular feature in the architecture of the Bank which has given rise to the preceding remarks, it has obtained more of professed admiration for its striking effect than of inquiry into the cause of that effect. For such inquiry, perhaps, there is no great need; because no one who has any eye at all for the picturesque in architecture, can be at a loss to determine in what the peculiar piquancy of that composition consists. Still, it is necessary that its merits, in that respect, should be distinctly pointed out, if only in order to force such earnest attention to them as might lead to similar happy results in composition. Precisely the same columns are used in other parts of the buildings, yet nowhere with anything at all approaching the same effect; and why? because here the composition is such as to be unusually productive of those "*accidents*" which give life and spirit to architecture—namely, vigorous *chiaro-scuro*, play of perspective, and richness of combination. There is not merely light and shade in a greater than ordinary degree, but variety of it—deepening shadows and brilliantly-touched lights when the sun begins to strike upon that angle of the building. Of perspective appearance, also, there is great variety, owing to the apparent changes of position between the external columns and the inner ones, and also to the contrasted disposition of them, the former being upon a curved line, the latter on a straight one. There is also another point of contrast between them which is equally judicious and happy, the outer columns being fluted and the others plain. This, while it adds to the variety of the composition, prevents confusion; and such is the value of the two inner columns, that without them the whole would be many degrees less admirable. They are, besides, both motived by and serve to warrant the mode in which the attic is carried across the loggia in a straight line. The only exceptionable thing is the door, or rather the appearance of door, when there can be no entrance from without, and where therefore a window or window-door—even had that also been only in appearance—would have been less of an impropriety. But a statue of some sort, sufficiently important in size, would not only have been an interesting object of itself, but have done away with all necessity for appearance of access into the loggia, since the latter would in such case have had an ostensible purpose as a piece of decoration.

VII. We get architectural criticism—as far as we do get any of it at all—merely by a mouthful of it at a time. What professes to be such is seldom more than a single condensed opinion expressed in the lump, wrapped up perhaps in a mass of cumbersome verbiage, or else enunciated in a tone of oracular decisiveness, intended to awe into silence and stifle inquiry and discussion. Even Horace Walpole's critical verdicts, albeit they were sometimes turned epigrammatically enough, were both flimsy and unjust, shallow and superficial. What he says of the campanile of St. George's, Bloomsbury, amounts to a mere sneer, and convicts him withal of being quite obtuse to picturesque effect in composition, and other architectural merits. As to Gothic architecture, Horace disqualified himself for setting up as a judge of that by his own precious Strawberry Hill, which would have absolutely horrified him had he possessed the slightest feeling whatever for that style. Yet, even vile as it is, Strawberry Hill has been deliberately praised by another discerning critic and writer on architecture, who says that the connoisseur would there find "all that is fascinating in the Gothick style." All that is fascinating with a vengeance! Were it possible to conceive that Dallaway was there merely joking, we could account for such praise as being condemnatory irony; but he seems to have been quite serious, and must accordingly have been exceedingly stupid also. In what its fascinations consist he does not say, although if any such merits there were, it behoved a critic to point them out, and to do so in such manner as so fix attention upon them. The comfort is, we lose very little by Dallaway's confining himself to only very hurried and superficial remarks on modern English buildings and architects, since what he does say, indicates but very mediocre critical talent and taste. What sort of an architectural critic Allan Cunningham was,—how well qualified to undertake the "Lives of British Architects,"—may be judged from the censure he passes upon the large open arches and loggias above them in the river façade of Somerset Place,—the most striking features, or rather the only striking ones, in that composition. In a fit of hypercriticism, Allan affects to be shocked at those very picturesque parts of the structure, as being quite contrary to all architectural principle and propriety, he asserting that the columns over the void of the arch produce "an appearance of insecurity that is al-

together intolerable;" which is as much as to say, that instead of suggesting the idea of strength and perfect security, the arch looks unequal to the due support of the columns. Nevertheless, it is certain that those arches are capable of safely bearing the weight of the columns, and can also safely bear the weight of what is much heavier still—namely, Allan's own leaden criticism.

VIII. Very great pity is it that St. Martin's Church stands just where it does, because it was in consequence allowed to interfere very injuriously both with the National Gallery and Trafalgar Square. Owing to its being obstinately insisted upon as a *sine qua non*, that the portico of the church should be exposed to view from Pall-Mall-East, the front of the Gallery was obliged to be set further back than it otherwise needed to be, and the site of the building—at best a very cramped-up one in its rear—considerably reduced in depth; in some parts, to little more than half. Hence, the interior of the structure does not at all realise the promise made by its extent of façade. Admitted it must be, that the architect did not economise what space he had so well as he might have done; still, that does not excuse those whose capricious whims thrust difficulties upon him where, without such addition of them, there were many to contend with.—On the other hand, as regards the "Square," its symmetry and rectangularity have been sacrificed for the sake of keeping its east side in a line with the portico of St. Martin's, which would still have shown itself, even had it not been made to come actually into that corner of it. After all, does the church display itself to such advantage, as to reconcile us to the inconveniences and deformities which it has been allowed to give rise to? The reply will be: "Hardly." Thrown open to view from such a distance as it now is, that portico is not so impressively striking as it formerly was. As it stood originally, the situation seemed altogether unworthy of it, owing to its being much too confined, and to the meanness of the houses huddled-up round the church—a species of contrast more picturesque than becoming or agreeable. Nevertheless, as it was then seen, the portico showed imposingly; and all the more so, because the view was confined nearly to that—the steeple not being seen unless it was directly looked up to; whereas now, as seen from a distance, the entire structure, that is, both portico and steeple—the latter of them anything but a graceful and well-composed object of its kind—are seen together; owing to which, the portico loses considerably, and the classical character that would else stamp it, when beheld at such a distance that only its exterior or columns are visible, is greatly interfered with, if not altogether forfeited, by the uncouth appendage which rises up immediately behind it. By no means is the view of the portico from Pall-Mall-East a prepossessing one.—Trafalgar Square itself falls very far short of what was only reasonable expectation for it. Strange perversity of judgment, bungling, and disregard of architectural disposition have been allowed to manifest themselves in it. Although the area itself seems to have been expressly planned for the reception of the Nelson monument, the column is, after all, not placed within it, but is pushed just out of it. The only assignable reason for such downright preposterousness is, that had it been erected in the centre of the area prepared for it, so lofty an object put just there would have had an unfavourable effect upon the front of the Gallery. Very true; but then that consideration ought to have been a *raison de plus*, and an all-sufficient reason in itself, for *not* adopting a column, more especialy as there was another thing of the same kind just by. There were many other designs which, besides being sufficiently well adapted to the situation, were far more original and artistic. It was, therefore, to be presumed that the second competition was for the purpose of enabling the committee to retrieve the error of their first choice; when lo! to the amazement of every one, the result was just the same as before,—which was only making matters worse than before. Far better—far more honest and honourable would it have been to have abided by their decision, than to make such show of intending to retract it. The least they could in decency have done, would have been to justify by some show of reason for it, a choice so strangly persisted in, and so strangely acquiesced in by those who had been trifled with. The best that can be said of the humdrum Nelson monument is that it serves to render the façade of the National Gallery perfectly satisfactory in comparison with it.

RAILWAY SECTIONS IN SIDELONG GROUND.

On Tables for Setting out the Width of Cuttings and Embankments on Sidelong Ground; and also Formulæ for Computing the Area of Vertical Section.

By R. G. Clark, C.E.

The object of this paper is to investigate some simple formulæ, and from thence to construct some tables, to enable the assistant engineer or contractor to set out the widths of cuttings and embankments on sidelong ground; and also to calculate the solid content of any portion of the ground. The subject may be resolved in the following proposition:—

Given the ∠ of inclination of ground, the depth (from field-book, &c.) of ground to the centre of balance or formation level, and the ratio of the slopes; to determine where they will meet the ground at surface.

Let H A F B D (fig. 1) be a vertical section of the ground; A B the formation line, represented by $2b$; the given angle of inclination of ground H D with the horizon by θ; the given depth O F from the stake O perpendicular to centre of formation level denoted by a.

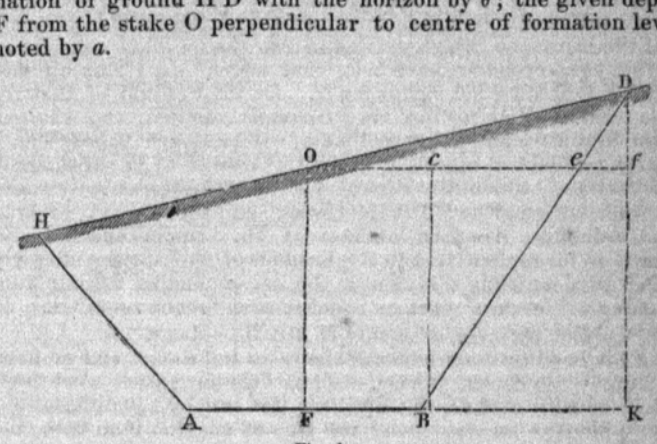


Fig. 1.

1. We will proceed first to determine a formula for O D. Let it be x; draw D K perpendicular to A B produced; O f parallel to A B K. Let D B be the given slope m base to 1 perpendicular; draw the vertical B C.

Let D $f = y$; then O c = F B = b; $ef = my$; also by similar triangles, C $e = ma$. ∴ O $f = b + ma + my$.

Now, by triangle O f D, right-angled at f, we have

$$1 : x :: \sin\theta : y. \quad \therefore y = x . \sin\theta.$$

Again, $1 : x :: \cos\theta : b + ma + my.$

$$\therefore x . \cos\theta = b + ma + my.$$

Eliminating y, then $x(\cos\theta - m\sin\theta) = b + ma$;

$$\text{therefore, } x = \frac{b + ma}{\cos\theta . - m\sin\theta} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

From the factor, $\frac{1}{\cos\theta - m\sin\theta}$ of the above formula, the Table No. I. is computed from 5° to 20°.

2. To find an expression for O H measured from O on the descent.

Draw H M (fig. 2) perpendicular to A B produced. Let H A be

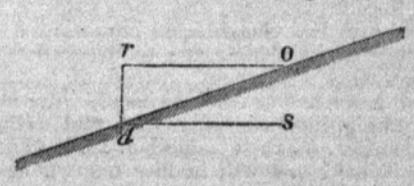


Fig. 2.

the given slope, ratio as before. Let H M = y'; then will A M = my'. Therefore, H G = N F = $b + my'$; also O $g = a - y'$.

By the triangle H g O we have $1 : x' :: \sin\theta : a - y'$;

therefore, $a - y' = x' . \sin\theta$; and $y' = a - x' . \sin\theta$.

Again, $1 \quad x' :: \cos\theta : b + my'.$

Eliminating y, we have $x'(\cos\theta + m\sin\theta) = b + ma$;

$$\text{therefore, } x' = \frac{b + ma}{\cos\theta + m\sin\theta} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

From this expression, Table No. II. is calculated by the factor $\frac{1}{\cos\theta + m\sin\theta}$.

3. We shall now investigate an expression for the area of the vertical section; the inclination of ground, depth, breadth of formation level, and lengths x, x', and also the ratio of slope, being all given.

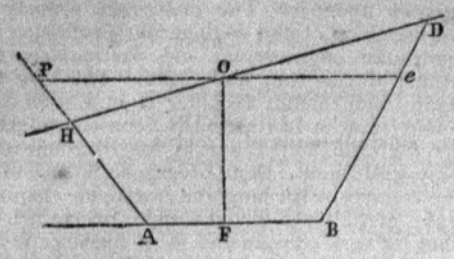


Fig. 3.

Through centre O (fig. 3), draw Pe parallel to A B; then P O $= b + m\,a$. $\therefore$ area of trapezoid P A Be $= (2\,b + m\,a)\,a$;

area of triangle P O H $= \frac{1}{2} \sin\theta \,.\, x' \,(b + m\,a)$;

and area of triangle D Oe $= \frac{1}{2} \sin\theta\, x\, (b + m\,a)$.

Consequently, the whole area of trapezium or vertical section = area P A Be + area triangle D Oe − area triangle P O H=

$$(2\,b + m\,a)\,a + \tfrac{1}{2}(b + m\,a)\,(x - x')\sin\theta \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The first column of the table gives the angle of inclination of the ground, and the adjoining column the nat sines to three places of decimals, to facilitate working out the area, as in equation (3). We shall now commence with the following Rules.

I. *To find the two lengths* O D *and* O H:—RULE. Add the half-breadth of formation level to the product of the slope and given depth; then multiply this sum by the corresponding tabular number, then will each product be equal to each length required.

II. *To find the area of section* H A B D:—RULE. 1st. Add the formation level to the product of the ratio and depth, and multiply this sum by the depth. 2ndly. Add half the formation level to the product of ratio and depth; multiply this sum by the difference of the two lengths, and again by nat sine of angle. Add these two products, and their sum will be the area.

Example 1.—Given the angle of inclination of ground 18°; slope, 1 to 1; depth, 45 feet; and breadth of formation level, 30 feet. To find distances of centre stake, area of section, and cubic content, when 100 feet in length.

Here $b + a\,m = 15 + 45 = 60$; $m = 1$; $\theta = 18°$; its nat sin = ·309

$\therefore$ 1·557 × 60 = 93·429 = O D. ·799 × 60 = 47·940 = O H.

By formula (3) we have $(30 + 45)\,45 + \frac{1}{2}(15 + 45)\,(45{\cdot}48)\,{\cdot}309$

$= 75 \times 45 + 30 \times 45{\cdot}48 \times {\cdot}309 = 4099{\cdot}5$ area required.

Cubic content = 409950·0.

Example 2.—Given angle of inclination of ground, 20°; slope, 1½ to 1; depth, 50 feet; and breadth of formation level, 30 feet. To determine distances and also area.

Here $a = 50$; $b = 15$; $m = 1\frac{1}{2} = \frac{3}{2}$; $\theta = 20°$; its nat sin = ·342

$\therefore$ $b + a\,m = 15 + 75 = 90$.

Now, 2·344 × 90 = 210·96 = O D. ·781 × 90 = 70·29 = O H.

By formula (3) for area we have

$(30 + 75)\,a + \frac{1}{2}(15 + 75)\,(140{\cdot}67)\,{\cdot}342 = {\cdot}7174$ area required.

Example 3—Given the inclination of ground, 18°; slope to be 2 to 1; depth from field-book, 20 feet; breadth of formation level, 30 feet. To find area and distances.

Here $b = 15$; $a = 20$; $\theta = 18$; $m = 2$. $\therefore$ $b + a\,m = 55$.

55. × 3·000 = 165· = O D. 55. × ·641 = 35·25 = O H.

By formula (3) we have

$(30 + 40)\,20 + \frac{1}{2}(15 + 40)\,(129{\cdot}74)\,{\cdot}309 = 2505$ area required.

Remark.—If the ground should ascend and descend, as in the adjoining diagram (fig. 4), then Table No. II. is to be used to find the distances. Table No. I will in like manner be required for ground descending from centre, as in fig. 5.

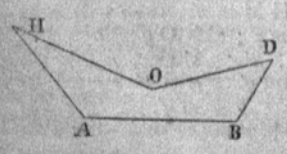


Fig. 4.

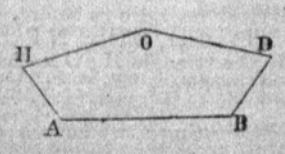


Fig. 5.

The Tables will likewise do for embankments—No. I. for the ascent from centre stake, and No. II. for the descent.

We shall now discuss the equations (1) and (2). Put them respectively under the following forms. T, T′, being tabular numbers, $A = b + m\,a$.

$$X = T \,.\, A; \text{ and } X' = T' \,.\, A.$$

Divide by T, T′, respectively; then $\frac{X}{T} = \frac{X'}{T'}$, A being eliminated.

Therefore the two distances, x and x', are to each other as their respective tabular numbers; consequently, the distances can be proved by a second operation. The Tables might have been carried up to 45°, but then they would require a greater number of places of decimals to insure greater accuracy.

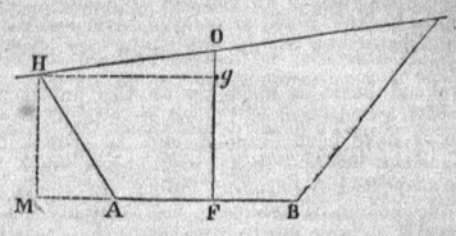


Fig. 6.

In taking the angle of inclination, the clinometer or common theodolite might be used; but if the spirit-level should be used, then we have only to measure from O downwards *any* distance, O r, (fig. 6), and then take the height with instrument; and then will the sine of angle of inclination O d s = r O d = $\frac{\text{height}}{\text{distance}}$.

Angle.	Nat. Sin.	TABLE No. I.—For O D. 1 to 1	1½ to 1	2 to 1	TABLE No. II.—For O H. 2 to 1	1½ to 1	1 to 1
5°	·087	1·100	1·156	1·217	·854	·881	·926
6°	·105	1·124	1·193	1·273	·832	·868	·910
7°	·122	1·148	1·230	1·323	·802	·851	·895
8°	·139	1·175	1·280	1·404	·780	·835	·885
9°	·156	1·203	1·328	1·496	·761	·820	·873
10°	·174	1·233	1·380	1·570	·752	·804	·856
11°	·191	1·265	1·437	1·666	·736	·790	·850
12°	·208	1·279	1·500	1·778	·700	·780	·844
13°	·225	1·330	1·566	1·902	·705	·763	·841
14°	·242	1·372	1·655	2·055	·696	·752	·826
15°	·259	1·414	1·731	2·230	·676	·740	·818
16°	·276	1·459	1·825	2·463	·663	·727	·800
17°	·292	1·506	1·930	3·600	·645	·717	·801
18°	·309	1·557	2·050	3·000	·641	·710	·799
19°	·326	1·613	2·186	3·040	·630	·698	·787
20°	·342	1·673	2·344	3·913	·611	·680	·781

Erratum.—The diagrams, figs. 2 and 6, in the above article, are transposed, for which oversight the printers are accountable; but beyond such transposition the error does not extend.

REVIEWS.

The Port and Docks of Birkenhead; with Maps, Plans, Sections, and Tidal Diagrams, and an account of the Acts of Parliament relating to the Mersey and Dock Estate of Liverpool. By THOMAS WEBSTER, M.A., F.R.S. London: Chapman and Hall, 1848.

Birkenhead has been a wonder, and has had its nine days, and very many are quite ready to believe that we have had enough of it. The announcement of such a town springing up in England was calculated to create as much astonishment as that of Aladdin's palace fresh coined by his wonderful lamp. It is not so easy to create great wonders in an old and settled country like this: cities of whitewash and timber-framing, metropolitan centres of slab-houses and log-huts, we leave to the far west of the States, or the sandy regions of Australia; and we should be no more surprised by the flourishing account of a Babylonian capital newly hatched in California, than by the sight of the three last joints of the sea-serpent's tail, or the repudiation of a fresh batch of Pennsylvanian bonds. Towns grow in the virgin soils of the new world; they are a natural production—or at any rate they can be planted as easily as cotton, or what the Americans dignify with the name of corn. We can reconcile ourselves to such creations as Fleetwood, or Kingston-upon-Railway, Wolverton, or Swindon,—the resuscita-

tion of Folkestone is a piece of the legitimate drama; but the public were truly struck with wonder to hear of the production on the shores of the Mersey of a great town, of the most solid construction and of the most magnificent proportions, provided with all the requisites of a perfect sanitary condition, with its labourers' houses, its park, schools, and market,—and this not a mere city of stone and Roman cement, but provided with such vast apparatus for commerce, that the envy of the London merchants was excited, and Liverpool gave signs how much she feared so great a rival near her throne. This, certainly, was a new phenomenon in England, for though we can add to London in one year a population equal to New York, or enlarge Liverpool with an addition as big as Albany, yet we do not throw our strength into new civic creations.

Since Birkenhead burst so suddenly on the public gaze the novelty has passed away,—and still more, from fortuitous circumstances, its glories have been dimmed, and its growth has been cramped; so that the interest it has excited has much worn off, and we shall be suspected of parading before our readers a stale subject, when we mention Birkenhead; but as we are not going to describe Morpeth Buildings, nor to investigate the statistics of the trade of the Mersey, nor to recommend the Liverpool merchants to give up and settle at Birkenhead, we may, perhaps, meet with a little attention, for Mr. Webster's book on Birkenhead gives us the opportunity of examining the plan as concerns its hydraulic features. Though Birkenhead may be a great town, and the docks a great speculation, yet there are scientific considerations involved in the harbour plan, which must render it a matter of permanent interest to professional men. If Birkenhead itself bears experiment, the walling of Wallasey is one of not less importance.

To make a dock is, in the hands of some engineers, a very simple operation; they scoop out a certain space on the shore, they run out piers into the water-way, or take in so much of the strand, and they are satisfied—though, for anything they know or care, the mouth of their docks gets choked up with sand, or the water at the entrance of the harbour is lessened, and a dock made for ships drawing eighteen feet will not take in those of fifteen. They have a great idea of dredging and sluicing power; and besides making a dock or harbour which fails in many of its essentials, they burthen it with a permanent establishment for getting rid of the silt which they have let in, and the sand-banks they have created, for it is surprising what very stupid and very careless people can do without knowing it. Mr. Rendel, when he was called in to make a plan for Wallasey Pool, thought it his duty to survey the whole water-way of the Mersey, and to make himself acquainted with the action of the currents and tides, so that, in laying down a deep-water dock at Birkenhead, he might not be shutting the outer gate to seaward—the Victoria Channel. Nothing is more common among seafaring men than to hear them complain, and complain with justice, that in consequence of new engineering works in some harbours, the depth of the water in the channel has been reduced, some dangerous shoal extended, some fixed bank made into a quicksand, or a bar which was troublesome enough before made a greater stumbling-block. If there be any up-navigation, that is sure to suffer when the point of discharge into the sea is injured, and the lighterman complains that the channels are choked, that the tide does not run up so high, or that he has less tide to carry him up; and the wharfinger finds that his frontage is stopped with sand and shingle. There is more bungling under the name of hydraulic engineering than perhaps in any branch of the profession. It is the opprobrium of engineering, that after hundreds of thousands have been spent on an hydraulic work, it is a complete failure; harbours are choked, piers pushed out only to push bars or shingle further seaward, and sea-walls are made with the most solid masonry and with the very smallest modicum of expense or capacity, so that they topple down before the walls are well set. So little is this branch of engineering appreciated by the public, that large tracts of available land—two new shires in fact—are left unsecured on the east and west coasts of England, when they ought long since to have been embanked. There is scarcely a river or water-way in the country which is not kept in a state disgraceful to the engineering science of England. Let any one leave the metropolis, and look at the shores of the Thames and Medway: marshes badly drained, or not drained at all; river walls made so steep that they are yearly cut into or undermined; and stones put year after year to be washed away, because they are put where they never ought to have been.

We do not know whether the government ought to take in hand, as in Holland, the care of our water-ways, for we place no confidence in what the government does. The constitution of the Tidal Harbour Commission is not such as to inspire any great hopes from government interference, for while that commission is ornamented with a military engineer in due course, there is not one civil engineer upon it. The one great remedy is by the exertion of the members of the engineering profession to improve the state of hydraulic engineering, and particularly to execute carefully whatever duties they undertake. This, we think, Mr. Rendel has done; and though we differ from him in some points, we have no doubt that he has carefully, conscientiously, and laboriously exerted himself in this survey for Birkenhead.

It is tolerably well known that Liverpool is one of the worst harbours in the country, with long and tortuous channels, among dangerous banks, and all the doubts and uncertainties of a bar-harbour, so that its very continuance as a harbour is precarious, and has, before this, been endangered. While Liverpool is a bad harbour, it is a bad harbour on a large scale; and those resources of science which are available for the improvement of small harbours can do very little on miles of sea-channel and acres of sand-bank;—still they can do a little, and it becomes of great importance, that in any operation within the estuary, all care shall be taken to prevent injury to the outer channels. Mr Rendel has tried to improve them.

The form of the Liverpool estuary is peculiar. It is wide above and narrow below, so that it has been compared to a bottle with the neck seaward. It is, however, outside the neck of the bottle that the sea-channels and banks are stretched out. Perhaps we may improve upon the bottle simile, by calling the estuary a curved powder-flask. Liverpool lies on the neck, on the concave side, and Birkenhead opposite, on the convex side. The wide part stretches up to Runcorn. Liverpool formerly had an inlet called the Liver Pool. This has been dammed up, and built upon; by which so much has been taken from the breakwater. The whole of the docks of Liverpool have likewise been taken from the breakwater, being constructed upon the strand. Thus the neck of the bottle has been narrowed very much more than it was originally.

Just above Liverpool a bank and shelf, called Pluckington Bank and Shelf, have been formed, which are not very advantageous to the docks before which they lie.

The Birkenhead shore has been untouched. It has a large inlet running up, named Wallasey Pool, and this has shown a tendency of late years to silt up. Indeed, considering Wallasey Pool, Pluckington Bank, and the general evidence, we should say that there is a decided action unfavourable to the good condition of the harbour.

The deepest water lies on the Birkenhead shore, so that it has a depth below the lowest dock-sills on the Liverpool side.

It will be seen, that whatever works are undertaken at Birkenhead, they may act upon the upper part of the flask, upon the neck and so affect Liverpool outside, and so operate upon the Victoria Bar and Channel. Whether this action was to be for good or evil very much depended upon Mr. Rendel; and he might have done as others have done—made his docks, and cared no more about it: but he has wisely taken a wider view, and tried to do all that was possible to improve the state of the harbour. This was done wisely, because the continuance of Birkenhead depends upon the good condition of the Victoria Channel; and if vessels cannot get over the bar outside, they will never be able to get into docks either on the Liverpool or Birkenhead side. Mr. Rendel's plan, therefore, is not one merely for making the Birkenhead docks, but for improving the harbours of Liverpool.

Wallasey Pool has a wide mouth, and runs, narrowing as it goes, about two miles inland, taking the drainage of a small district. This Pool is mostly dry at low water. The opening of this Pool is perhaps a mile across.

This Pool may be taken as two parts, the mouth or funnel, and the upper part. Mr. Rendel's plan is to take advantage of a ledge of rock which runs across the neck, and shut off the upper part by a great dam with lock-gates, and having a line of sluices as hereafter described.

The upper part constitutes a float of 150 acres, kept up at high-water mark, and on the sides of which docks, wharfs, warehouses, and building-yards may be formed. Around this float a river-wall is to be built as frontage to the wharfs.

The mouth of the Pool is to be embanked, except a low-water basin of 37 acres open to the Mersey.

The sluices in the dam are to be so arranged as to be near the bottom line of the outer low-water basin, so that on being run out they shall sweep the bottom of it. This they are to do during a part of the tide only, so as to concentrate the action, to keep the basin and its mouth free from silt, and to send the water down to

the Victoria Bar at the best time for action on it. By the construction of the sluices, the water, instead of being poured down to tear up the bottom of the basin, will be sent along in a sheet, so as to prevent the silt from depositing itself. This sheet will be sent below the water in the basin, and Mr. Rendel thinks it will act to sweep the silt 2,000 feet.

It will be seen that by blocking up the Pool and inclosing the greater part of the strand, a considerable body of tidal water is displaced.

Mr. Rendel expects by straightening the shore on the Birkenhead side that the access of the tide to the upper Mersey will be improved, and that the scour being increased Pluckington Bank, on the Liverpool side, will be reduced, a better entrance will be made to Wallasey Pool, and a more favourable action will be exerted on the Victoria Bar.

The plan seems open to the objection that injury must ensue from the tidal displacement at Birkenhead, particularly as by the construction of new docks on the Liverpool side a further displacement takes place there.

Mr. Rendel says that this is of no importance in the case of the Mersey. If the river were of a funnel shape an obstruction below would impede the passage of the tide up, and diminish the quantity of water available for scour. He allows that injury will ensue if an obstruction takes place in the upper Mersey, because there will be less room for the water to accumulate; and therefore there will be a less body to scour down on its ebb. He contends, however, that the displacement on the neck of the flask is of less importance, as the water there is of less power for the scour than the water returning from the upper Mersey. The tide will always have time and power to force its way up the neck to supply the reservoir in the upper Mersey; and the state of the channels in the neck is determined by the state of the upper Mersey, and not of the neck. He contends on the ground of the improving state of the Victoria Channel, and, notwithstanding the displacement by the docks at Liverpool, that operations at the neck cannot injure the Victoria Channel. Pluckington Bank, he affirms, is formed by the set of the current on the irregularly-shaped shore of Birkenhead. By straightening the Birkenhead shore, and making it parallel with the Liverpool shore, the neck will be made more efficient, the tidal body passing up will deepen it, and Pluckington Bank will be worn down, though he does not say it will sweep it away altogether.

This is really a summary of the harbour question; and we believe we have put it with sufficient succintness and clearness to enable our readers to exercise their judgments upon it.

The arguments and researches of Mr. Rendel in support of his case are well worthy of perusal, for they exhibit very able treatment and high powers of mind. It is in the preservation of these that the practical value of Mr. Webster's book consists; and it is fortunate that the editorship fell into Mr. Webster's hands; for as it is chiefly an abstract of the evidence, a mere lawyer would have got rid of the practical points, and the book would not have been of the least service to engineers,—whereas it is one which will be usefully added to the library of every member of the profession.

The formation of a harbour at Birkenhead is not new to engineers, for, in 1828, Telford, Stevenson, and Nimmo were employed on a plan by Mr. Laird, sen., and Sir John Tobin, and recommended the formation of a canal from Wallasey Pool to the Dee at Hilbree island, near its mouth, so as to get another access to the sea. This is a resource which Birkenhead still has, and which with its progress it will avail itself, but which will not checkmate Liverpool. Liverpool has, by the plan proposed for an out-harbour at Formby Point, a cheap means of providing more efficiently for all that could be done by a new sea outlet to Birkenhead. Formby Harbour could be made cheaply; while two short cuts to the Leeds and Liverpool Canal, and to the Liverpool and Southport Railway, would allow of goods being carried cheaply and quickly into the Liverpool docks; and for steam traffic, Formby Harbour would beat the Hilbree Canal. Mr. Rendel's plan may be considered as novel in its whole arrangements and treatment. Mr. Telford in looking at the Mersey is reported to have said: "They have built Liverpool on the wrong side of the river."

We shall now take some stray gleanings from Mr. Webster's book. Lieut. Walker, R.N., says that Pluckington Bank is caused by two opposing tides or eddies from Wallasey Pool meeting and causing the silt held in suspension to deposit itself. The straightening of the Birkenhead shore would remedy this.

Birkenhead, we may note, besides being the deep-water side, has the advantage of being the weather-side; while the docks on the Liverpool side, most exposed to the waves breaking over the sand-banks, are the most liable to silt up.

The area of the float at a high tide is 208 acres, the frontage 4½ miles. In the dam, Mr. Rendel proposes a pair of tide-gates of 70 feet opening, the level of their sills being the same as that of the Prince's dock, at Liverpool. This float would allow steam-tugs to enter, which is not the case at Liverpool. Mr. Rendel calculates on the movement of the steamers likewise in keeping his channels clear. Besides the tide-gates of the great float; Mr. Rendel proposes a lock of 50 feet wide and 200 feet long, which could be worked during ten hours out of every twelve, in a spring tide, for vessels drawing 17 feet water.

We shall give in Mr. Rendel's own words his plan of sluicing:—

"It is proposed to run down daily any quantity of water between the level of the tide of the day and that which may be considered best as the permanent level of the water: so that, supposing the water were retained at a permanent level of thirteen feet above the old dock datum, the average high-water of spring tides being 18 ft. 3 in. above that level, there would be 5 ft. 3 in., the difference between the permanent level and the tide of the day. The running off the water is a very important feature in the plan: the idea is to make sluices, or apertures, under the great gates and the tide-gates, passing out near the level of the bottom of the great basin, and consequently under the whole of the gates. The openings for the discharge of the water will be between the bottom of the basin and the level of the sills of the tide-gates and of the locks, as low as we can conveniently get them; say for argument sake, ten feet below the level of low water of average spring tides. The sluices will be so formed as to be five feet square at the top on the inside, and they will be gradually widened in horizontal dimensions, so as to produce a kind of sheet of water within two feet of the bottom of the great basin, and inasmuch as the separating piers of those apertures will only be at the point of outfall about two feet thick, the effect will be to have one wide sheet of water of the width of the basin; the consequence of that is, that we shall be able to operate upon the bottom of the basin, not in the usual way of a large bore of water tearing up everything before it, but a sheet of water which we can regulate to any degree of force which we like, by the sluices on the inside. I should also say further, that we have the sluices there, because they will operate most efficiently upon the straight part of the basin; we propose to have the same kind of sluices between the little dock which we have called the Bridge End Dock, and the arm of the basin running up to it, operating in the same way precisely. I wish it to be distinctly understood, that we do not propose to run those sluices in the ordinary way of sluicing. I want to give the water, which is to be discharged out of this great basin, more the effect of a river passing through with a gentle current, than a great body of rushing water, and I arrange the sluices with this view. It is also manifest that a basin of such capacity as this basin, will have lying in it a number of vessels, say of from six to ten feet draught of water; those very vessels will be the means, with a gentle current, of keeping the basin clear with the daily operations we shall employ in running off this water.

If the basin were unoccupied the effect would not be so great as it will be the basin being occupied. If the basin were formed at the level of low water, or if it were not occupied, the effect of the sluicing would not be so great as it will be from the fact that vessels are floating in the basin, whether in large quantities, or small; if the quantity of vessels is small, I would then give the water a greater current; if it is large, I would then give it a gentler current, so that we can command that kind of current passing under those vessels from their being afloat, which will keep the bottom clear of the daily accretions.

Also we can run off the water at those periods that experience will dictate to be the best. We are not bound to run it off at low water, or any particular period of the tide: that would be regulated by a regard to all the circumstances of the case.

I know from considerable experience, that many harbours are kept open entirely by the vessels lying in those harbours; the river is forced to pass under their bottoms, and in that way the water is kept at a proper depth. I believe that is notorious."

There will be the power of running off 1,600,000 cubic yards of water at spring tides, which will be available for scouring. The most available water for scouring now passing out of Wallasey Pool is 1,390,000 cubic yards; that is to say, the water passing off after half-tide.

Mr. Rendel's estimate is, for cofferdams and other temporary works, £15,323; excavations, £80,470; masonry, £198,513; gates and bridges, £21,268; draining, £22,572; land and contingencies, £53,379. Total, £391,908.

The peculiarity of Mr. Rendel's plan is the damming-up of the upper Pool, so as to make a float. Messrs. Mawdesley and Smith had proposed simply to deepen and wall the Pool, which was supported by some of the opposition parties. Mr. Rendel affirmed that this would do no good, but leave the Pool even more liable to fill up, as it would receive the water at an earlier time of the tide, when charged with a larger quantity of matter.

Mr. Rendel's researches on the tidal actions of the Mersey

were very minute; but to be fully understood require the explanatory maps and sections accompanying Mr. Webster's book. We shall, however, attempt to give an abstract of Mr. Rendel' evidence in the House of Lords:—

"The estuary of the Dee, and the estuary of the Mersey, and the character of the two rivers are manifestly wholly different—their forms are different. They are different in this respect; the Dee is for the whole extent of it a shallow estuary; the Mersey, from the contraction at its mouth, has an exceedingly deep channel opposite Liverpool, containing an enormous mass of water, but immediately that it widens out in the same form as the Dee, it loses its depth and becomes a shallow estuary; therefore, suppose the tide to come up, as I describe it with reference to the large chart, as at present—and nothing in our works can prevent that, for the works are within the gorge—it comes up in a large body, presenting to all intents and purposes, the head of a wedge, and it gradually tapers out, losing its solid and compact form as it advances up the estuary. It is manifest that if we can make that wedge into a uniform column, as we shall do by these works, we shall perfect the efficiency of the channel after these works are made; the part outside Seacombe is perfectly untouched; we do nothing to that. Then, in order to ascertain precisely the whole economy of this tidal action in the estuary, and to satisfy my own mind, and in order to give evidence before your Lordships, I had tidal observations taken at Formby, which is, in fact, the headland on the Lancashire shore; observations were simultaneously taken at Prince's dock, which is the narrow part of the gorge of the estuary; also at New Brighton, Fiddler's Ferry, and Warrington Bridge, so that I have been able to trace the relative heights and the relative times of high water of the same tides at all those points, and I have done it at spring and at neap tides. The results I will give from the diagrams I have before me.

The width of the river at Egremont—the point which corresponds with the north end of the Liverpool docks—at high water, is 4,030 feet; the sectional area of the channel at that point at high water spring tides is 236,449 square feet. At Seacombe, only 3,000 feet within that point, the width is reduced to 3,060 feet, and the sectional area to 184,622 feet; it is altogether a gorge at that point; it is completely the gorge of the estuary, which has been defined by the works of the dock trustees on the one side and the natural rock of Seacombe on the other. At Wallasey Pool the width is 6,640, it will be reduced by building the wall to assimilate with the other sections, namely to 3,350 feet. At Woodside pier, the width is 3,500 feet, therefore the effect of the wall is to make the shores parallel, and consequently to take off this great width which Wallasey Pool occasions. That wall, when made, will in my opinion, improve the channel and course of the river; it will directly accomplish that object, and one immediate result likely to follow is the taking away of Pluckington Bank formed by the tide setting into Wallasey Pool and occasioning an eddy. The consequent good effect will be, that the quantity of water at the least, if not more, which now goes into Wallasey Pool, would go up into the estuary, and by going up into the estuary it must necessarily be of greatly more value to the maintenance of the estuary and the scouring power of the river than passing into the pool. There will be nearly 300 feet greater width opposite our works than at Seacombe. The minimum section of the river being at Seacombe, the next smallest section is at Woodside, and the next at Tranmere. The sections at Seacombe and Woodside will continue the smallest sections after the works are completed. If Pluckington Bank be swept away, it will make a difference greatly in favour of the narrows as they exist at present; it will make a larger section, and improve the estuary above. After Tranmere, the estuary becomes very wide; after you get above the bulb the bottle commences.

This section is the profile of the river; it is on an exaggerated scale as to height compared with length. Here is the Victoria Bar, then the Crosby Channel fall into this enormous cavity; here we have Seacombe, which is the narrowest part of the river; the bed rises up again opposite Garston to the level of low water. The river has excavated for itself within these narrows, within which it has been confined, a channel quite down to the rock in this particular place. The greatest depth at Egremont at low water spring tides is 67 feet. The greatest depth at Seacombe, which is determined by the rock, for it is scoured down to the rock, is 52 feet; the greatest depth opposite Wallasey Pool is 62 feet; opposite Woodside the greatest depth is 64 ft. 7 in., this is at low water spring tides. At Tranmere, we get 61 ft. 4 in. according to our soundings. It would appear that except in hollows in the rocks the sand has been scoured down to the rock, but as the current passes in and becomes impaired in efficiency by those hollows or irregularities on the shore, there are parts where banks have begun to accumulate, and it is only in certain parts that we can detect rocks by the plummet. The Mersey presents the character of a deep narrow channel supplying the estuary above; it presents the character of a narrow artificial gorge supplying a shallow extensive estuary.

According to the observations I have made there can be no doubt that the supply of water into the estuary above, depends upon the momentum generated in those narrows. The bulb at Wallasey Pool detracts from the momentum. The straightening the wall in the manner described would improve the current and increase the momentum, inasmuch as the present irregular shores make irregular currents; those irregular currents act upon each other and impair the general effect. If they can be made direct they are made more efficient, and consequently they will send a larger body of water up into the estuary, or at all events they will send that water up into the estuary which now runs into Wallasey Pool. I am as great an enemy as any one to the general question of abstracting water from estuaries, but there is peculiarity in this case which takes it out of the general class of causes of the abstraction of water from estuaries.

To ascertain the strength of the currents, I had accurate observations (with watches adjusted) at Egremont, Seacombe, Wallasey, Woodside, and Tranmere, and having a fleet of boats and a steamer to attend us, we put down floats, so far submerged that the wind could have no effect upon them, in the centre of the stream and on either side, far enough from the shore to feel the strength of the current, and the floats were observed as they passed each of the lines of the sections at the above places. The distances were great enough to give as accurate a result as could be obtained by any experiment of the kind, none of them being less than 2,600 feet, and the greater part from that to 3,000. The mean velocity of the tide upon the flood from Egremont to Seacombe was 6·173 feet per second, from Seacombe to Wallasey it was 7·211 feet per second; which expresses this, that the tide heaps up on the seaward side at Seacombe Point faster than that section can pass it through, so that it runs faster to relieve itself on the inside of the Seacombe Point than it does from Egremont to Seacombe. You have that increased velocity by the increased head outside Seacombe. From that section to the section at Woodside, the velocity is reduced to 5·891 feet per second. That arises from the current being impaired by passing into the bulb; it has, in fact, the effect of cross currents and eddies, as I have described. From Woodside to Tranmere the velocity is 5·33 feet per second. The ebbs are the very reverse. It will be observed that on the flood the tide was strongest from Seacombe to Wallasey Pool; upon the ebb, the strongest current is from Seacombe to Egremont; there the velocity of the ebb tide was 6·703 feet per second; the velocity of the ebb from Wallasey to Seacombe was 6·139, and from Woodside to Wallasey 5·49. These are ordinary spring tides. The velocity of the ebb from Tranmere to Woodside was 5·54 feet per second, which proves that the water is heaped up by the tide at Seacombe Point faster than it is vented; anything which can be done to improve the channel of the estuary between those narrows and the upper narrows must necessarily tend to vent that quantity of water with greater facility. Those were the results of actual observation, the theoretical results on a comparison of the sections agreeing with them as nearly as can be expected.

The object of these tidal sections is to show how the tides flowed on the days of observation. At the time stated it was high water at Formby, which is quite at the mouth of the estuary. At the same time, if you carry on your eye to the Prince's dock you find that the tide is heaping up, actually rising up, at the Prince's dock. Then if you go on to Ellesmere Port, you find that the tide is still rising; although at the time it is rising there it has fallen at sea; and so, all the way on to Runcorn and Fiddler's Ferry; and you get the profile at all the points by the different lines laid down here, which in words is this: that inasmuch as the tide had by flowing into the estuary attained a velocity in passing through these narrows at Liverpool, its own acquired velocity or momentum carried it forward, and heaped it up in the estuary according to all these lines, for it would be impossible if that were not the case to account for the fact, that the tide does so rise; and it is just this—I will suppose the fluid to be a solid; if a solid has acquired a given velocity, we know perfectly well in mechanics that unless some force interposes to stop the velocity of the body it will be carried on; and it is precisely so in this case, the water flows on by the impulse that it has received at that narrow gorge, and it rises above its level. If the elevation were due to nothing more than statical pressure, which is merely the pressure of the head without the velocity, it would terminate its course, for there is no law of nature to make it go further. What would be the state of things in an estuary like the Dee, would be determined by the form of the shore and other questions, but here you have the peculiarity so strongly marked, that you cannot mistake the cause. The effect there would be, that as the mouth of theDee is wider than its head, it would receive a larger wave than would be due to the upper part of the Dee, and, therefore, if it had acquired sufficient velocity, the water would accumulate up the Dee to a certain extent; but inasmuch as the extent to which it would accumulate is due to the velocity of the stream, it could not attain the same head in the upper part of the Dee as it does in the Mersey; it depends on the velocity. I should say this, that inasmuch as the profile represented is that which is due to the statical pressure (which is nothing more than head without force or velocity); all that is above that must be due to impetus: for we see here in the Mersey what we see in every river, and what we see in the Dee: instead of the narrow part being at the top, the narrow part in the Mersey is at the mouth; therefore, so far as is due to momentum, if you could make the Mersey and the Dee at all agree, it would follow, that you would in the Dee have an enormous heaping up compared with what you have in the Mersey. If you could by any possibility give to the water entering the Dee the same velocity as the water entering the Mersey, keeping the section the same, it would heap up here quite in the same way as it does in the Severn; but it cannot have that velocity, because there is not the same cause to excite it, namely, the contraction.

For determining how much the tide has risen up the estuary above its level at the gorge, I take the level at Prince's Basin, which is in the gorge. I will take the tide on the 1st of June, which was a spring tide. Suppose we start with the tide at high water at Prince's dock, which is in the gorge

at Liverpool, it would be 1 ft. 1 in. higher at high water at Ellesmere Port, and fifteen minutes later in arriving at that point; 1 ft. 10 in. higher at Runcorn, and would be thirty-five minutes later than at Liverpool; it would be 1 ft. 9 in. higher at Fiddler's Ferry, one hour after it was high water at Liverpool; it would be 2 ft. 3 in. higher at Warrington bridge, 1 hour 25 minutes after it was high water at Liverpool. Without going through the details of each observation, the mean of three spring tides was 1 ft. 1 in. higher at Ellesmere, 1 ft. 10 in. at Runcorn, 1 ft. 8 in. at Fiddler's Ferry, 2 ft. 3 in. at Warrington. On the mean of the three neap tides, of the 8th, 9th, and 10th of June, there was still an elevation, but it was reduced on account of the stream not being so strong at the gorge, to 5 inches at Ellesmere Port, 11 inches at Runcorn, 10 inches at Fiddler's Ferry, and only 9 inches at Warrington; these differences are due to the differences of the neap and spring tides, or in other words, the differences of the velocities through the gorge are as 8 inches at Ellesmere Port, 11 inches at Runcorn, 10 inches at Fiddler's Ferry, 1 ft. 6 in. at Warrington; and it follows, that anything that would strengthen the velocity through the gorge at neaps, would necessarily tend to make the approximation nearer between the elevations at those different places at neap tides, as compared with springs.

The difference in the quantity of water which passes up the estuary at springs and neaps, I have taken from Captain Denham's survey; and if you could get the water at neap tides to stand at all those different points with the same differences above the Prince's dock as it does at springs, you would get an increased quantity of water (18,000,000 or 20,000,000 of yards) up the estuary; any increase of the momentum in the gorge would tend to increase the quantity going up. The observations led me to that conclusion, and I come to no other from the phenomena; at all events I am perfectly convinced that all the water that now passes into Wallasey Pool, would go up into the estuary. It is a mathematical question which I am not going to touch, whether more would go up; but philosophers have endeavoured to show, that a bulb upon a pipe (all other things being equal) would prevent the same quantity of water being discharged as would be discharged in the same time if the pipe were parallel, and this is a similar case, but I am not going into that question."

Random Hints on Railways and Railway Legislation. By ALEXANDER DOULL, C.E., Assoc. Inst. C.E. London: Weale, 1848.

This is a timely warning against the bill of the Railway Commissioners, particularly addressed to the engineering profession. It is so clear and practical that we hope it will not be without its proper effect; at any rate, Mr. Doull deserves the warmest thanks for this exposure of the mischievous measures of the commissioners.

After showing the inconsistencies of the standing orders, and explaining the process adopted in preparing a line of railway for parliamentary examination, Mr. Doull goes on to analyse the amended bill. The chief amendment is the lowering the deposit by way of security from £500 to £200; but which for a line of 200 miles, would still leave the enormous sum of £40,000 in the hands of the Railway Commissioners, to be fooled away in such manner as they may think fit,—but which, at all events, is a serious impediment in the way of all new lines of railway. Mr. Doull very well observes, that the commissioners are quite ready enough to do work for the money,—indeed, the way in which they make work would deserve credit for its ingenuity, if it were not so objectionable from its decidedly mischievous tendency.

As is very well known, a preliminary survey, often extending over miles in breadth, is necessary to select the line which is to be surveyed in detail. No provision, however, seems to be made for this, or the bill is inconsistent with its performance. Most probably, Colonel Brandreth and Sir Edward Ryan are unaware how the survey of a railway is carried out. The fourth clause of the bill requires that "the promoters of any proposed railway shall apply to the commissioners for authority to make the surveys necessary to enable them to determine the line and level of such railway," &c.; but the fifth clause requires that "ten clear days at the least before making such application, the said promoters shall give notice by advertisements, each in the same words and form, in the *London Gazette* and in some newspaper published or circulating in each county through which the railway is proposed to pass, such intended application specifying the course of the line of such railway," &c.

Of course this cannot be done without a preliminary survey, and how is this to be effected ten clear days before the engineer can apply to the commissioners for leave to go over the ground?

Again, if this notice and this permission be as a protection to the occupiers, it is difficult to conceive how a notice is to be framed to cover the wide extent of country over which it is necessary for the engineer to go, if he is to choose the best line of railway.

It is evident to all practical men that a very large expense must be incurred for advertising voluminous notices (drawn up by lawyers) in the *London Gazette* and a number of country newspapers. It will be worth the while of the enterprising proprietor of the *Surrey Times* to publish it all the year round, instead of bringing it out as now for the occasion of the advertisements of intended applications to parliament for railway bills..

Mr. Doull thinks from the sixth clause that the permission to survey only extends to the very lands through which the proposed line of railway is to pass. If so, a large sum of money has to be paid down, much time has to be wasted, and a cumbrous process to be gone through, for a permission which is worth very little.

The tenth clause, regulating the return of any remaining portion of the £200, provides that "one month after the bill for giving power to make the railway, in respect of which such deposit was made, shall have passed or been thrown out or withdrawn by leave of either House of Parliament, the commissioners shall by a draft or cheque signed by two of the commissioners order the balance standing to their (the depositors) account, in respect of such deposit, to be paid to the promoters by whom the deposit was made." —Mr. Doull observes, that the framers of the bill do not appear to have contemplated the return of any portion of the deposit to those promoters who may not advance so far as the threshold of the legislature. We may add, that there is an opening for litigation, in case of any dispute among the promoters of a new company, such as has happened before, and snch as may happen again, under the auspices of Mr. Spackman and others. If Mr. Spackman should give notice to the commissioners not to return the remaining deposit to the committee of the railway company, the commissioners may be very well disposed to act upon the hint, and wait for the direction of a court of law.

The thirteenth clause provides that "before the said promoters, or any of their officers enter upon any lands to survey the same, or to mark out the line of their proposed railway, as hereinafter mentioned, they shall give to the occupying tenant thereof not less than two nor more than seven days' notice in writing of their intention to enter and survey the lands." The object of giving not less than two days' notice explains itself, but the restriction as to not giving more than seven days' notice must often be most inconvenient to surveyors and engineers, for within seven days many circumstances may occur to delay the survey, while no inconvenience can accrue to the occupying tenant from any length of notice. Under this clause, it might frequently become necessary to serve a fresh notice, the first seven days' notice having expired.

Mr. Doull contends, and with justice, that the number of occupiers who would require to be noticed previously to commencing the survey or levels, would be considerably more than the number at present necessarily included in a railway book of reference, even supposing the survey to extend only to the usual breadth of 20 or 30 chains. It would therefore be necessary to get up a reference-book before commencing the survey; and this would be attended with very great expense, besides the risk of some occupier being left without a reference.

The fourteenth clause is in keeping with the rest. It enacts, that "the said promoters shall mark out the line of the proposed railway by means of stakes fixed in the ground not more than thirty yards apart, and in such manner as clearly to point out the proposed line of such railway; and they shall put up posts along the line, so marked out at convenient distances for the purpose of showing the level of such line, and shall mark on such posts in legible characters the number of feet and inches at which the rails are proposed to be laid above or below the surface of the ground."

Our readers will agree with Mr. Doull, that staking out a line of railway, and exhibiting the levels in feet and inches along the line, is a very difficult and complex operation. He estimates that it would double the expense of preparing parliamentary plans and sections. A higher class of surveyors would have to be employed, and a number of devices must be resorted to and superior instruments used to stake out curves of given radii with accuracy, in the face of the numerous obstacles to be encountered, and of the variety of circumstances to be met with, on an extended survey.

As more damage must be done by staking out the line than by an ordinary survey, another charge will be imposed on the companies, and further claims for compensation be given to the landowners and occupiers.

A new set of parties must be employed in painting the level-posts.

What good is to be got from stating, in "inches," a level which will differ whether the land be ploughed or unploughed, whether it be trenched or in grass, we do not profess to see. It can only cause a serious expense without answering any useful purpose.

At present, staking out is delayed to the period when it can be

undertaken for a purpose of practical utility, and when it can be conveniently performed.

As landowners and occupiers can now refer to the plans without having the line staked out, and as engineers can check the levels of rival lines from those plans, going over the ground with the plans in their hands, it does seem very hard upon the companies that they should incur such expense for the officers of Royal Engineers, who are to be employed to inspect the line. In fact, if such parties cannot go over the ground without having the line staked out, they must be utterly incompetent for the discharge of the duties properly belonging to their own profession, and to the performance of which it is desirable they should be restricted. It will be open to a factious opposition to cavil about every one of the posts; and the military engineers and the whole party may be employed in ascertaining that the post is wrong by two inches above or below the line.

Clause 21 provides that the plans are to be deposited and inspected. The inspector, who knows as much about civil affairs as he does about civil engineering, is to hold courts along the line of the proposed railway "for the purpose of receiving information or suggestions from any persons interested in such proposed railway, either as the promoters thereof, or as the owners and occupiers of lands on or near to such line or otherwise." A very cheap way of annoying the companies and putting them to expense, will be by the landowners and farmers attending the inspector's court, and occupying the time of the staff by raising all kinds of objections.

The twenty-fourth clause is an ambiguous one, giving the commissioners power to allow the promoters to amend their plans after inspection.

Clause 25 provides that a second deposit is to be made; and this is followed by another ambiguous and inconsistent clause.

Mr. Doull thinks that Clause 32 contemplates a second inspection of the line of railway.

It behoves engineers to be on their guard against this most tyrannical, mischievous, and vexatious measure, which will place them under the inspection of their inferiors, the military engineers, in every operation of a survey; and they are to be subjected to the judgment of these latter, whether a level be rightly taken or a curve properly laid out.

It will be seen that this bill subjects railway projectors to the following new extent of unprofitable expenditure:—

The depositing of £200 per mile with the Railway Commissioners.

The advertising of the intention to survey.

The preparing a reference book for the survey, and the serving of the notices on the occupiers.

Staking out the line, marking the levels in feet and "inches," and setting out the curves.

Making two deposits of the plans.

Preparing amended plans.

Attending the inspector in his inspection of the line as staked out; and fighting for the accuracy of the line, and against the objections of the local parties.

After all this has been done, the old preparations for encountering the ordeal of standing orders have to be made; for the new regulation of the Commons, providing for notices being sent through the post is quite inoperative, as service has to be proved, and the Lords require the old mode of service.

Our readers will agree that any system of legislation more disgraceful to a country than that by which railway companies are harassed, was never attempted or perpetrated.

Ancient and Modern Art, Historical and Critical. By George Cleghorn, Esq. Second Edition. Blackwood, Edinburgh and London, 1848.

It is stated that the object of this work is to present, in a popular form, a brief sketch of ancient and modern art; and to avoid the faults of other publications, which are of no use to the ordinary reader. By way of carrying out this pledge, the two volumes are filled with long passages from the French and Italian, and snatches of Greek and Latin, which are not likely to be very well understood by the public, which are not needful in themselves, and which do not even prove the learning of the author. As to the execution of the work, without being original, it is loose and unsatisfactory; there is a hash of the opinions of foreign writers on art, and the only novelty is the criticism of the author on English writers and reviewers. It especially fails in giving a clear idea of any one work, school, or style, and a reader taken from the public would acquire the smallest amount of definite information from its pages. It is a very difficult task to give an abridged view of an extensive subject, so as to communicate exact ideas; indeed, an abridgement requires as high a degree of ability as an extensive work. It is not surprising, therefore, if Mr. Cleghorn should utterly fail in this attempt. As from some petty provincial feeling, there is more space devoted to the buildings, sculpture, painting, and painters of Edinburgh than of any other place—indeed, a large part of the two volumes—the public who buy this book on its title, will have no more reason to be satisfied with the quantity than with the quality. The work has such small merits, that we should not feel called upon to notice it, if it were not that it is likely to be taken for a popular work, as being a second edition emanating from publishers of reputation.

A popular manual of art has yet to be written and is much wanted; but it must convey definite information and descriptions suited to practical men, and less general criticism of artists and works unknown to the public and not particularised. Mr. Cleghorn's account of the Munich school is the best that he has given us, but it is quite inadequate; while a proper account of what has been done and is doing there is one of the best incentives to the encouragement of art here.

We must do Mr. Cleghorn the justice to say, that so far as his abilities go, he is sincerely desirous of promoting the interests of art. It may be some excuse for his defects that the present work is the offshoot of a pamphlet in favour of the imitation of the Parthenon on the Calton Hill at Edinburgh, under the name of a National Monument for Scotland. He is, therefore, a partisan of pure Greek and what he calls idealism; he allows of Gothic; but seems to hanker most after Italian. If it were not for the metaphysical bent which effects all who are born north of the Tweed, and leads him into the discussions about idealism, he would be catholic in his artistic predilections. His idealism is, however, more confused than that of any German, because he is attached to the study of nature; and while holding up the imitation of nature as the great end of art, he cannot make out how to reconcile it with idealism. He has been born in the faith of idealism,—and though his convictions are starting arguments constantly against his faith, and though his practice is opposed to it, yet idealism he persists in maintaining. What it is he has not been successful in describing; in one place it seems to be the genius and imagination of the artist which constitute idealism: but this again does not agree with statements elsewhere. The late Haydon, although he talked very much about it, could never make himself understood. The upshot always was "Nature and the Elgin marbles." Mr. Cleghorn is strenuous in his abuse of what he calls the sect of naturalists, but without producing any arguments except in their favour.

He seems to be much more successful in reproducing M. Quatremère de Quincy's definition of imitation. This is a fitting introduction to a treatise on artistic criticism. Imitation in the fine arts, says M. de Quincy, is the production of the likeness of a thing, but in another thing which becomes its image. It is not a reproduction of the thing, it is not its exact likeness, which can only be the result of a reproduction; but it is the image of a likeness, to be animated by the mind of the observer. Hence, an attempt at illusion fails because the artist takes on himself to perform the functions of the spectator, and leaves the latter little or nothing to do. The originals of most of the figures of Raffaelle, Rubens, or Murillo would produce much less interest than the paintings: they would often excite the reproach of being ugly or clumsy women. The best illustration of this fundamental principle of the fine arts, but one which Mr. Cleghorn has not adduced, is that derived from the drama. On a small stage, and in a short time, we are made to see the greatest men of antiquity, the revolutions of years, and the consummation of the most important events—the actors being men familiar to us even through the disguise of costume. The mind, however, takes its part with the actor, and shares in the realization. We do not want

> "A kingdom for a stage, princes to act,
> And monarchs to behold the swelling scene."

These accessaries are useless when the audience can supply their absence. The great dramatic poet explains the theory of imitation well, when he says to his audience:

> "—— 'T is your thoughts that now must deck our kings,
> Carry them here and there; jumping o'er times;
> Turning the accomplishment of many years
> Into an hour glass."

As a perfect illusion is not necessary, but hurtful, so there are bounds placed to limit the extent of art, and to limit the extent of each department of art,—bounds best observed in the greatest height of art, and soonest overstepped in its decadence.

On the legitimate application of imitation all the fine arts depend, and this is their bond of union; it is only in the vehicle

used, or the sense addressed, that they differ. We are now agitating for the catholicity of the three arts of design—painting, sculpture, and architecture; but we cannot expect a perfect development of the fine arts, unless their three other branches—music, the drama, and poetry—be likewise cultivated. The attempt to sever single arts, which has failed, is a ground for want of confidence in any system which steps short of completeness. In what do all our complaints and all our inquiries as to the low state of art end? In a conviction of the low mental condition of the professors of art. When the painter has once taken his brush in hand, the sculptor his chisel, and the architect his compasses, he bids farewell to education and enlightenment, he gives himself up to what he calls his art, and narrows and cramps his mind just at that time when it should be freest in its expansion. Precisely for the reason that the artist has no education, the scholar has no knowledge of art; and art is kept back from this state of affairs, and not from the want of manual capacity in our artists, or of adequate encouragement from the public. There have been opportunities enough lately, but they bring forth only Buckingham Palace or Trafalgar Square, art-union pictures or pigtail monstrosities. The schoolmaster has been sent abroad; but till our artists are better educated men, and more on a level with those of Greece and Italy, art can have little hope. We do not want academies of art so much as we want schools, liberal training, and the power of reasoning justly.

Among the six fine or imitative arts, there are marked distinctions. Painting or design, sculpture, and architecture are material in their production; poetry, the drama, and music are immaterial, and the latter two in their performance are transient or fleeting. The three latter have, however, the power of reproduction of the model work to such a degree as materially to extend their social influence. Painting by the means of engravings, and sculpture by means of casts, have this power of reproduction in a less or more modified degree, but the progress of science promises to give these arts greater resources; and although some look unfavourably on the machinery of copying and piracy, we cannot but believe that the artist will gain by being brought into communion with a greater mass of the public. The artist and the public must work together, they must feel for each other, they must join to produce the wished effect. Shakspeare working for the public of his day, and Dickens for the public of this, are under a stimulus which the artist at the present time too rarely feels. The incentive to immortality, the conscientious discharge of a patriotic duty, the inspiring influence of the goodwill and fellow feeling of applauding millions ought to operate on the artist as they do on the statesman, the general, or the poet, and ought to produce greater results than the grovelling selfishness which yields up its task on the payment of the stinted and allotted price, careless of anything but the money reward and the personal gratification.

Architecture has for its province the execution of single and isolated monuments. It is not easy to reproduce the Parthenon or St. Peter's, and the architect has every inducement to devote himself to the production of works the merit of which he will not divide with the copyist, the printer, or the engraver,—which he wants no translator to make known to other nations, but which are felt and understood by people of all countries and all ages. Architecture has, too, this distinction, that it has an immediate and an obvious utilitarian character. The painter, the sculptor, and the musician minister indirectly to the uses of society; the poet and the dramatist may propose a moral end, but it is not needful they should do so; whereas there are few works of architecture which do not bear the stamp of usefulness. It may be thought by some enough to appeal to this sense of usefulness, but until the architect can satisfy himself that Newgate or Bedlam engrosses the favour bestowed upon Westminster Abbey and St. Paul's, he will do well not to be unmindful of the artistic relations of his profession. As the mighty dome of St. Paul's is seen from so many points towering over London, how well does it mark the wide expanse of population crowding below. There is a greatness in the sight which cannot pass unacknowledged, while the statesman and the moralist knows too well the influence of great thoughts and great associations on the public mind to neglect those means by which they can be awakened and upheld. Athens, it is true, sank with the glories of the Parthenon untarnished, but not until the living spirit of art had been quenched.

The imaginative or creative power of the artist is what is not allowed for in Mr. Cleghorn's theories. His idealism resolves itself into the study of nature and the adaptation of the fine part of one individual to the fine part of another to constitute an ideal or perfect whole. He quarrels with Hazlitt for affirming that the ideal is the preference of that which is fine in nature to that which is less so; but he does not set up in its place anything which is clearer. Perhaps there is no difference. The naturalists, as represented by Mr. Hazlitt, say, "There is nothing which is fine in art, but what is taken immediately, and as it were in the mass, from nature." Mr. Cleghorn, for the moderate idealists, does not traverse this, but says, that "Ideal art is finer than nature;" though from what we can make out, ideal art is only selected nature.

As to the question whether it is better to represent individual nature with individual defects, accidents, and peculiarities, or to represent Jupiter with some of the features of the lion, and Hercules with the neck of a bull, to say nothing of fauns, satyrs, and centaurs,—this seems to us a question which, if solved in favour of the latter side, does not give any valid support to the idealists. Indeed, there is nothing which has ever yet been brought forward which shows that the Greeks owed their excellence to anything but the study of nature, or that there is any other mode of attaining excellence in art. We are therefore the more hopeful of the future of English art, as at any rate we have the groundwork of a study of nature; and this, supported by a prudent reference to the old masters, as confirmatory of the course of study, will, with a more liberal education and a more catholic feeling of art, give us artists of whose works we shall not be ashamed.

Railway Engineering; containing a General Table for the Calculation of Earthworks. By T. BAKER, C.E. London: Longman, 1848. 8vo. pp. 64.

We regret to perceive that Mr. P. Barlow has permitted this book to be dedicated to him, for we are sure that he was ignorant of the dubious character of the honour conferred on him by the unscrupulous author. There need not be the slightest delicacy or hesitation in affirming that the whole performance is a collection of gross plagiarisms. The formula for the super-elevation of the outer rail of a railway curve is taken from De Pambour. Methods which have long been published for setting out curves, the author claims as his own, on the plea that they were *privately* communicated to his pupils, and that some years ago he sent to the "Gentleman's Diary" a paper on the subject, *which was rejected.*

The "General Table for the Calculation of Earthwork on Railways, &c." is a direct copy from the "General Table for facilitating the Calculation of Earthworks for Railways, Canals, &c." by Mr. Bashforth. There is not even a colourable variation from the original in the copy,—*it is an exact reprint, line for line and figure for figure;* with a few additions, *but not a single omission.* Every one of Mr Bashforth's tabular numbers re-appears in Mr. Baker's table. We had intended, in order to render the plagiarism palpable, to print a column from one table by the side of the corresponding one in the other table; but after getting half way through the labour of copying the figures, we found that there was not a single alteration or omission, and therefore abandoned the task as useless.

A general reader, not familiar with the character of earthwork tables, might deem the similarity accidental or inevitable—just as if two persons published different tables of common logarithms or square roots, the tabular figures must coincide where both are correct. The slightest consideration, however, will show that the present is not an analogous case. A great number of earthwork tables has been published, but none except Mr. Baker's has the same figures as Mr. Bashforth's: and for this plain reason,—that other tables, such as Mr. Bidder's or Sir John Macneill's, are applied by methods, and for purposes, entirely different. Sir John Macneill's, for instance, are not general, but have the results for *particular* slopes and bases, worked out ready to the engineer's hand. Mr. Bidder's table, on the contrary, is general, and considers the prismoid in three separate portions. Mr. Bashforth's is also general, but considers the prismoid in two portions; one of which has no real existence, but being merely assumed for facility of calculation, is ultimately subtracted. Now considering the perfect independence of these methods, it is clear that the tables founded on them, though entirely different from each other, may lead to identical results. But the only person who has adopted Mr. Bashforth's very original plan of considering the slopes to be hypothetically *continued* till they meet in an apex, is Mr. Baker. He therefore is the only person who *could* use the same figures.

We have too much confidence in the right feelings of engineers, to suppose for an instant that this attempt to take the fruit of high talents and unweared toil from the lawful owner will prove successful. In our apprehension, the literary offence is much aggra-

vated by the attempt made in the work under review to throw dust in the eyes of the reader, by abusing the author whose tables are copied. The attacks commence in the preface, and are continued at intervals to the end of the book, with all the emphasis which italics and capitals can give them. For example, speaking generally of other previous tables, our author allows that "none of them are accompanied with directions for finding the contents from the sectional areas, which is the most important part of such tables, except Mr. Bashforth's; *but his method of applying them is erroneous.*" Now, the assertion, which we have given in the author's own italics, is not only untrue, but it would not be uncharitable to assert that it is put forth to disguise the real relation of his own method to Mr. Bashforth's. The supposed error refers to the calculation for side-long ground (or cuttings or embankments on the side of a hill, where the height of the slopes is unequal), and is established by taking a perverse and preposterous example—that of two sections, 4 chains apart, of the areas 10,324 feet and 400 feet, respectively. As if in a length of 4 chains, no intermediate sections would be taken where the first section was more than *twenty-five times* the last!

Setting aside the extravagant nature of the case supposed, Mr. Bashforth's method, even if so applied, is just as likely to give a true result as that which Mr. Baker would substitute. We are told, that by neglecting the area of the triangle, the former method gives a result $7\frac{1}{2}$ per cent. too small: but it is just as likely that the substituted method gives the result as much too great; for the ground may undulate so much, that the error may be either in excess or diminution. In a case like the present, where the ground falls so much in the direction of length, that the heights of one end-section are only one-fifth those of the other end-section, great irregularities of surface must be supposed to intervene. For instance, suppose a valley or deep hollow occurred somewhere in this length of four chains of cutting, Mr. Baker would tell the contractor that he had to remove all the contents of the valley, which, in reality, nature had already excavated for him. There is no guarding against such errors, except by the precaution which every reasonable engineer adopts where the ground varies considerably—which, in the present case, would be practically inevitable—and which Mr. Bashforth's method supposes,—that of taking *frequent* sections.

Our worthy author has not borrowed his predecessor's table of Proportional Parts,—which, as we explained in a former review, is printed on card, with a moveable index of wood sliding in a groove. It is estimated that by this ingenious contrivance, the table is made to contain all the calculations which, extended, would occupy a surface 42,250,000 times its present area. To have adopted this table also, would have been too palpable a plagiarism; Mr. Baker, therefore, contents himself with copying, *figure for figure*, the first twenty-one lines of it, which constitute *his* (!) "Table No. 2;" and the reader is informed (p. 48), that in cases which this "Table No. 2" does not include, he must work out the calculations for himself.

It is not to be expected that every practical person who calculates quantities for contractors, should understand the mathematical principles on which the particular tables which he uses are based. But it is within the simplest comprehension, that the two methods under comparison—and they alone—proceed on the assumption that the slopes are hypothetically continued to their intersection. It is also not a matter of reasoning at all, but one of mere eyesight, that Mr. Baker has re-printed Mr. Bashforth's calculations identically. The only differences are these—Mr. Baker's table is printed in a less distinct manner; to Mr. Basforth's table of 65 heights (reprinted without a single omission) seven more heights are added: lastly, of the table of Proportional Parts, the first twenty-one lines are reprinted, and as to the 42 millions and odd remaining calculations, which the sliding index ingeniously effects—why, the reader is left to calculate them for himself.

The Steam Navy.—Mr. Edward Whitley Baker has been appointed by the government to go out with James Brooke, the Rajah of Sarawak. Mr. Baker is attached as engineer to the Mæander frigate, and is to have charge of a steam launch, to be used in getting up the small rivers and creeks for surveys and in search of pirates, and is to be at the service of the Rajah in Sarawak and Labuan as mechanical engineer. We are glad to see from this appointment that the Admiralty are really desirous to improve the engineering service of the navy, by employing efficient practical men like Mr. Baker.

REGISTER OF NEW PATENTS.

BALANCE BRIDGE.

John Harvey Sadler, of Holbeck, Leeds, iron merchant, for "*Improvements in constructing bridges, aqueducts, and similar structures.*"—Granted July 7, 1847; Enrolled January 7, 1848.

This invention relates to the construction of cast-iron girders for continuous bridges, viaducts, or aqueducts, and other improvements relating to railways. Fig. 1, is a side view made according to this invention of cast-iron girders *c*, strongly jointed and bolted together at *a*, standing upon piers of stone or brick *b b b*, each girder *c*, being cast from one and the same pattern, or where no very great length is required, two parts *c c'*, may be cast as one piece; in either case from the points *d*, will constitute one girder, which is from centre to centre of two arches, and the two parts on

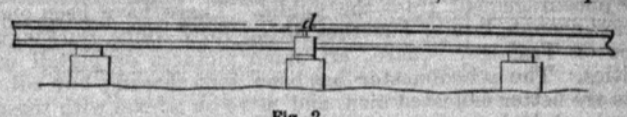


Fig. 2.

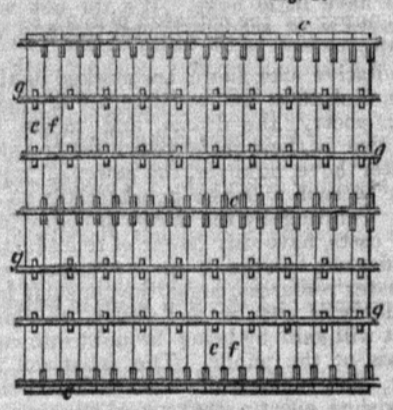


Fig. 6.

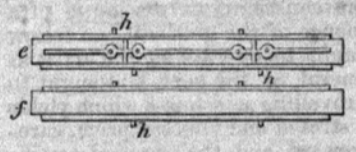


Fig. 4.

Fig. 5.

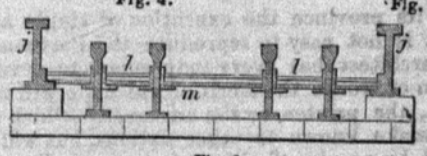


Fig. 3.

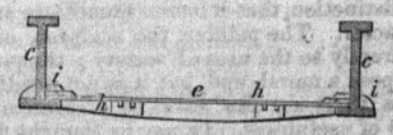


Fig. 7.

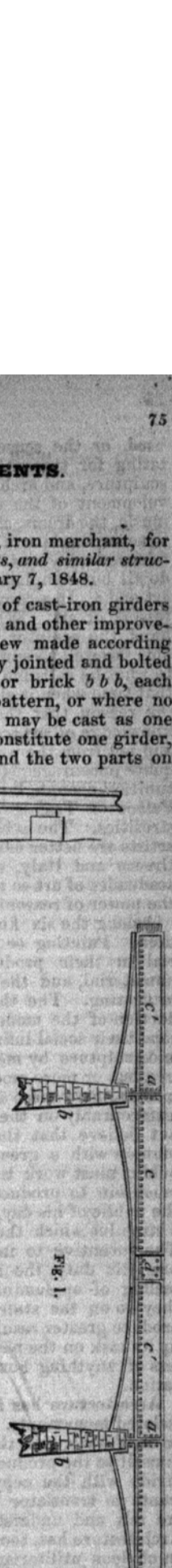


Fig. 1.

either side of a bar *b*, will balance each other, consequently, there is no weight or sway comparatively speaking in the centre of each arch. It will be seen that each girder is loose and at liberty at the centre of each arch *d d*, and though strongly jointed together by means of plates on each side, they will allow for any contraction or expansion required by change of the atmosphere; and fig. 2, is a transverse section of this joint, showing how the toothed-plates fit into similar teeth at the ends of each girder where they meet at the centre. Fig. 3, is a plan of the cast-iron flooring for bridges, &c., consisting of plates of cast-iron. Fig. 4, shows these plates upon an enlarged scale, the underside uppermost and not closed together, the better to explain how strength may be given to these plates to bear the rails and any weight required to pass over them; and fig. 5, is a transverse section, showing how these plates are fastened together, and bolted to the girders by the brackets *i i*. The covering or flooring-plates *e* and *h*, are shown to be a foot in width, and of the length from girder to girder corresponding to the width required for the railway.

The plate upon which the chairs are securely bolted is seen to have three ribs or flanches cast upon the underside in order to give the requisite strength, and also holes cast through it for bolting and securely fixing the chairs for holding the rails. There are studs about an inch square cast upon the sides of each plate, and each plate has holes cast of a size exactly to fit and receive these studs, (see *h*, fig. 5, which is a side view of these plates,) it will therefore easily be understood that if these plates were shut or closed together, these studs would enter into the holes cast in each for that purpose, clearly showing that the whole covering or flooring will be so united and securely fastened, so as to form one general mass of support to the rails and the weight passing over them.

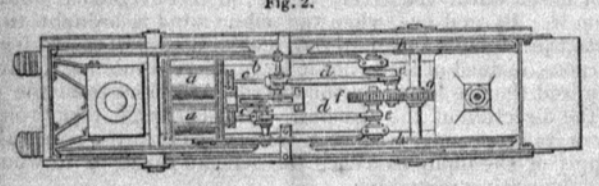
LOCOMOTIVE ENGINES AND BREAKS.

GEORGE TAYLOR, of Holbeck, near Leeds, Yorkshire, mechanic, for "*Improvements in the construction of engines and carriages to be used on railways.*"—Granted June 3; Enrolled December 3, 1847.

This invention relates, firstly, to improved arrangements of the cylinders of locomotive engines, and the parts which communicate the reciprocating motion to the driving-wheels, for the purpose of concentrating the driving power of the actuated pistons, so as to communicate an even rotating motion to the axles of the driving-wheels, and also to distribute the moving power (without first concentrating it) to one, two, or more pairs of driving-wheels in a uniform manner. Secondly, this invention refers to an improved break, for stopping the progress of carriages along the line of railway; such apparatus being also suitable for sustaining its carriage on the rails, in case of the breaking of an axle. Thirdly, this invention relates to an improved arrangement of tender. Fourthly, to certain improvements in mounting the wheels of railway carriages.

The improved arrangements are shown in the annexed engravings. Fig. 1 is a side elevation, and fig. 2 a plan, in which the

Fig. 2.



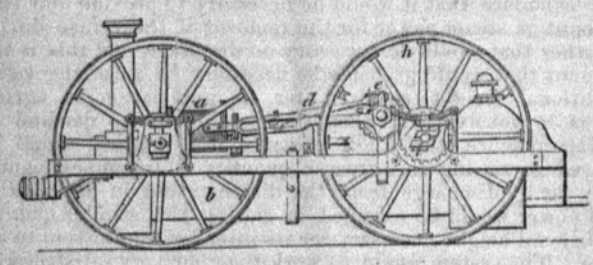


Fig. 1.

motive power, communicated to the pistons of the working cylinders, is concentrated in a line drawn longitudinally through the centre of the plane of the engine. *a*, *a*, are a pair of cylinders, placed over the end of the boiler *b*, nearest to the smoke-box; *c*, are the piston-rods, with cross-heads, which slide in guides fixed to the outside casing of the boiler; *d*, *d*, are rods for connecting the piston-rods to the cranks *e*, which cranks are attached one to either side of a central wheel *f*. The periphery of this wheel is provided with cogs, for gearing into or driving a wheel *g*, keyed to the axle of the driving-wheels *h*. In order to insure the proper gearing together of the wheels *f* and *g*, and allow of the play of the bearing-spring, the guides, in which the axle-boxes or journals of the driving-wheels *h* slide, are made at an angle, as shown at *i*, fig. 1. By referring to the figures, it will be seen that the axles are placed above the boiler, and, therefore, wheels of large diameter (say from 10 to 15 feet) may, if required, be employed with safety; the oscillation of the engine being, in great part, avoided, by the central and uniform driving of the axle of the wheels *h*, and the weight of the engine being near the ground. When it is desired to make all the wheels driving-wheels, their shafts may be connected together by rods and crank-pins, as now generally employed.

The specification describes two other arrangements of mechanism, for communicating the reciprocating motion of the pistons to the axles of the driving-wheels.

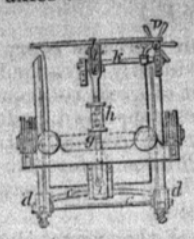


Fig. 4.

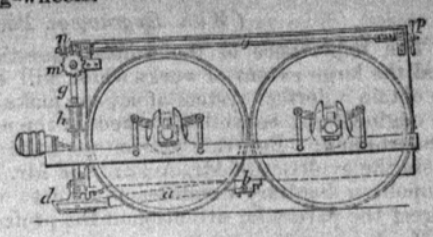


Fig. 3.

The improved apparatus or break for retarding and stopping the train is shown at fig. 3, a side elevation of a tender, with the apparatus attached thereto; and fig. 4 being an end elevation. *a* is one of two levers, attached to the bottom of the carriage, and intended to vibrate slightly upon centre-pins *b*. At their outer ends these levers are connected together by a cross-rod *c*, and are thereby caused to move simultaneously when any motion is communicated to them. *d*, *d*, are flanged skids, attached to the outer end of the levers *a*; and they are provided, at their under surface, with a block of wood, the grain of which is vertical. These skids are intended to be depressed on to the rails, when the speed of the train is to be ckecked; and the flanges, which are formed on the inner side of the skids, will act as guides and keep the carriages on the line of rails, in case of the breakage of an axle. *e* is a strong spring, stretching across from one skid to the other, and taking into slots or openings formed in the upper part of the skids. This spring is embraced, at the middle of its length, by a hoop *f*, which is jointed to a vertical shaft *g*, composed of two parts, and capable of being adjusted, in its length, by a threaded connecting-piece *h*. The upper end of the shaft *g* is forked, and between its prongs two antifriction rollers *i*, *i*, are mounted. In the sides of these prongs, and between the centres of the rollers *i*, longitudinal slots are cut, for the purpose of receiving the axle *k*, of a cam *l*, which is in contact with the peripheries of the antifriction rollers. The axle *k* is mounted in bearings affixed to the end of the tender, and to its outer end a worm-wheel *m* is keyed. This wheel gears into a worm *n*, mounted on one end of a shaft *o*, which turns in bearings at the side of the tender; and at its other end a hand-wheel *p* is keyed, for the purpose of giving it a rotary motion. Let it now be supposed that the skids are required to be let down on to the rail,—the hand-wheel *p* is turned, in order, by means of the worm *n*, to move round the wheel *m* and its axle, which carries the cam *l*; the larger radius of this cam being now brought into contact with the lower antifriction roller, it will depress the vertical shaft *g*, and communicate, through the spring *e*, an elastic pressure to the skids, whereby they will be made to bite the rails, and retard the progress of the train.

The third improvement consists in carrying the axles of tenders through or above the water-tank, whereby the weight is brought near the rails, in a manner similar to that of the engines. By this arrangement larger wheels than usual may be employed with safety; the weight of the load which the tender carries being brought much nearer the rails, whereby the oscillation is in great part prevented.

The fourth part of the invention relates to improvements in mounting the wheels of railway carriages,—the railway axle being composed of two parts, one being solid and the other tubular. The solid axle is made to carry one of a pair of wheels, and the tubular axle, which is slidden over the solid axle, or otherwise placed over it, receives the other wheel. The advantage of mounting wheels in this manner is, that they will be allowed to turn independently of each other. In applying the improvement to axles, as now constructed, one boss is turned down, and a collar merely is left; the axle is then coated with "Paris white," or other suitable substance, and afterwards heated in a furnace to a dull red heat. When in this state a tube or hollow axle is cast around it,—the ends of the hollow tube being inclosed between the boss and the collar of the inner axle. On the contraction of the metals, the inner and outer axles will, by reason of the intermediate filling substance, be enabled to revolve independently of each other, but will be in no danger of separating, as the collar keeps them securely together. When, therefore, the wheels are respectively secured in their places by the ordinary means, they will be free to revolve independently, and be as little liable to derangement as if mounted on one solid axle.

SANITARY IMPROVEMENTS IN THE SEWAGE.

(With Engravings, Plate V.)

The importance of the sanitary question increases every day, and the large extent of works which will evidently be carried out to obtain a perfect system of sewage make it of great consequence to engineers to be well informed of the most approved modes of construction. For this reason we have given copious extracts from the evidence of Mr. Austin and Mr. Phillips, before the Metropolitan Sanitary Commission, and to which we beg leave to direct the particular attention of the profession.

H. Austin, Esq., C.E., at the request of the commissioners made a survey of the Surrey and Kent district of sewers, and gave the following evidence relative to the flat district of Lambeth, the Borough, and Rotherhithe, as shown in the plan, fig. 1, Plate V.

"There is little doubt that much improvement might be effected in the present system of sewage, but it could only be carried out at vast expense; and to extend this system over the whole district, so as to render it general and complete, even under such improved arrangements, would not only be ruinous in cost, but the great evils after all would only be lessened, not removed. With a district so situated, nearly flat, and for the most part several feet under high-water mark, all attempts at providing an adequate natural drainage, direct into the river, must end in failure. Do what you will, it must be a cesspool system still. A small additional current of two or three feet may certainly be obtained in some cases by lowering the outfalls to low-water mark, but the advantage of this, carried over a distance of two miles or more, would scarcely be appreciable, and could be carried out only at immense expense. It appears to be absolute that this artificial state of things should be treated artificially, and mechanical appliances brought to bear to lift and discharge the refuse constantly as it is produced. Intermittent drainage is somewhat more barbarous than intermittent water supply. It does seem extraordinary, that with the steam-engine applied in almost every useful relation of life, its adaptation to this great purpose for the relief of flat districts of towns of its refuse and water should never have been attempted. It was very satisfactory to me to find, on proposing the system to Mr. Chadwick, that the idea of its practicability had already been impressed on his own mind, from observation as to the efficiency and small expense of pumping, for the purpose of agricultural drainage. We have ample experience as to the facility with which refuse may be pumped, in its application, in several instances, to agricultural purposes. It only remains a question as to the best arrangement of the drainage to realise the object in the most efficient and economical manner.

The district to be drained should be apportioned into convenient sections or divisions, the drainage of which would be totally independent and distinct, converging to the centre of each division with any desired current, and from these centres the liquid would be raised by steam-engines, placed at any convenient point in connection with them by pipes. The skeleton plan (fig. 1, Plate V.) of the populous part of the Surrey and Kent district will best explain my meaning, it being understood that the divisions of the district there represented, the position of the centre points or wells, and the situation of the engine power, are only assumed for the purpose of illustration, without at all presuming that they would be the most desirable to adopt. These are matters, the correct determination of which would demand much consideration and study of local circumstances and arrangement. Beyond the consideration of these circumstances, the extent of each division would be limited only by the amount of fall that it would be necessary to preserve to allow of a certain maximum size of drain, and the depth of digging that might be thought desirable.

The most important consideration appears to be the size and material of the drains, and I have founded my calculations on the basis that the maximum size of the main outfall drains should not exceed a dimension that would be conveniently manufactured in pottery clay, so as to allow of the establishment, *throughout, of a complete system of pipe drainage rather than of brick sewers.* I therefore fix the limit of the largest drain at 2 feet diameter, that being a practicable size to manufacture. Taking then a perfectly flat area—which is the worst case for calculation—assuming a total fall of 15 feet from the extreme points to the centre, upon an area of half of a square mile or 320 acres, this will give a current of 1 in 250 as a minimum, and a 2-feet drain, with that fall, will be more than sufficient to discharge the whole refuse of the densest population upon that extent of surface, with an improved constant supply of water of 100 gallons per day per house. With such arrangements, there would have to be discharged from each division of half a square mile nearly one million gallons per day; but as by far the largest quantity is used in the busy time, from nine to one o'clock, I calculate a capacity sufficient to discharge the whole quantity in that time.

It would be essential that these drains should be capable of removing also the whole external refuse of the streets and houses. I assume, therefore, that the system should be capable of accommodating a fall of rain equal to an inch and a-half in 12 hours, a good soaking quantity that would soon cleanse the whole surface of the streets and houses, and convey away the refuse. This amount being added to the house supply of water, the total quantity produced at such times in each division would be 200,000 cubic feet per hour.

The only question for consideration as to fall, would be to fix a safe limit for the total inclination of those continuous lines of the drainage that would have to convey the water from the extreme points to the centre. Having decided upon that, the rate of inclination should be graduated from one end to the other; because the accelerated velocity of the stream, as it would approach the centre outfall, would admit of considerably less inclination of the drainage than at the commencement; or, on the other hand, would admit of a great reduction in the size of the pipes. All the collateral or intermediate branch-drains, it will be seen, would have so considerable an amount of fall, as to afford the opportunity of putting them all in of a very small size.

The engines may be fixed in any spot most convenient and advisable, and there need be only one pumping establishment for the whole district (as shown in the skeleton plan, fig. 1), to which main pipes would lead from the several centre wells, precisely as would be practised in raising so much water from a well at a distance. From the engines, one or more discharge-pipes, to convey the whole refuse, would lead to the most convenient outlet in the river, as shown by the double dotted line. The arrangement here submitted would offer this great advantage, that the pollution of the whole southern bank of the river would at once be avoided, as the liquid refuse could, with equal facility, be discharged at any spot lower down the river, where no inconvenience would arise from it. By-and-bye, when the public mind is brought to appreciate the value of this material, and to apply it to its legitimate purpose, instead of throwing it away, there would be nothing more required than to lay down the distributing-pipes from the engines in the direction of the demand. The discharge pipe would then serve its proper purpose of a waste-pipe into the river, when the supply of the liquid exceeded the demand for it, or it would lead into depositing reservoirs.

I calculate that it would be necessary to provide four times the amount of steam power for the removal of the refuse during wet weather that would be necessary on dry days, and this is the very amount that would probably be necessary to raise the refuse the additional height required for its application to agriculture. Thus, in wet weather, when there would be no demand for the sewage manure, the whole power of the engines would be employed in raising the greater quantity of liquid sufficiently high only for its discharge from the district; and in dry weather the full power would be engaged in raising the smaller quantity the additional height necessary for its intended application to agriculture. The system would so work together very satisfactorily as a perfect whole.

The cost of this improved system of drainage will not amount to more than one-fourth of the system now pursued in the Surrey and Kent district. This commission has recently given notice of the intended execution of works, involving an outlay of £100,000, to be expended in a few main lines of drainage, which, for the real and important purposes of sewerage—the removal of the liquid refuse from the houses—will be of no earthly benefit to the inhabitants, but will serve only to obstruct future improvement; whereas the outlay of this amount on the plan proposed would actually suffice for the construction of the entire street drainage, including every court and alley, of more than one half of the most populous part of the district comprised within an area of four square miles immediately south of the river. The perfect drainage of the most crowded district on this system would cost on the average £2 per house, with an annual charge of 2*s.* per house, for annual expense of engine power. To repay in 30 years, with interest, the whole cost of the public or street drainage, together with complete private or house drainage, with stone-ware water-closet basin, and including the above annual charge for engine power, would involve a rate of 7*s.* per annum, or about a third of the annual cost of emptying a cesspool, where at all decently kept."

Mr. PHILLIPS, C.E., gave the following evidence as to the system of sewage adopted by him :—

"Solidity of execution in construction, economy of materials and labour, combined with strength to bear the lateral and vertical pressures of the ground, and efficiency in affording the best channel for quickly conveying away the sewage, are the essential requisites for a sewer. The circle affords the most capacious area of all plane figures having the same circumference, and conversely its circumference is less than any other figure of the same capacity. It, therefore, supplies the greatest capacity for receiving the water, with the smallest frictional surface, and the least consumption of materials. As regards strength: when the pressure from the ground around a circle is the same, it is equally distributed throughout the entire thickness composing the arch; for, as the extradosal length is greater than the intradosal length, the arch is necessarily made up of a series of wedges all pointing to the centre of the circle; hence the circular form prevents the earth outside of it from forcing it in, and from disturbing it, provided the pressure be equal, while upright walls in the same circumstances would most probably be unable to withstand the pressure.

The removal of sewage and prevention of deposit of matter in sewers are entirely dependent on the quantity and velocity of the water running through them. In order therefore to keep them well washed out and cleansed, the utmost scouring force should be imparted to the streams. A semicircular, or still narrower and deeper-curved channel of a semi-elliptical or catenarian form, concentrates the flow on a small area of friction, heaps it up, and so increases its velocity, and makes it more powerful in lifting, holding in suspension, and carrying away all matters which may find their way into the sewers, than a wide and flat channel. A sewer, therefore, having an arched crown, curved side walls, and a narrow and deeply-curved bottom, which, combined together, give *the shape of an egg with the small end placed downwards*, is, in my opinion, the best and most efficient form for all branch sewers. It would appear however from what has been stated, that the circle, from having a more capacious area and less rubbing surface than any other figure, is the best shape for *all* sewers. But this is not the case; for although the surface of contact of the egg-shaped sewer is somewhat greater than a circle of the same area, yet by contracting the channel and so raising the height of the stream, the ratio of velocity and consequent *power to scour* is increased thereby, as will be evident on experiment being made. It is the prerogative of the egg-shaped sewer, therefore, to combine in its form, capacity, economy, strength, and efficiency.

For the short collateral branches of the sewers in street, courts, &c., the smaller they are, (provided they be large enough to receive and carry off storm waters in addition to the ordinary run), the less chance will there be for them to choke up. In the course of my experience I have examined hundreds of drains, and I have always found small drains and sewers which had a moderate fall, and anything like a good supply of water, quite clean and perfect in that respect. I anticipate, indeed I confidently entertain an opinion, that with a combination of the water supply and a tubular system of sewerage and house-drainage, the whole of the annoyance now experienced by the public from defective drains and sewers may be made to cease.

If constant currents of water be carried through the drains and sewers, though the currents may be small, yet provided they be constant and concentrated on very narrow and smooth bottoms, they will keep the sewers clean. Where the supply is intermittent, the matter discharged from the house-drains, meeting with no current, accumulates. In order to prevent deposit in drains and sewers, there must be a certain degree of velocity and force given to each current, so as to produce agitation equal to, or rather greater than the *vis inertiæ*, or weight, mass, figure, and superficies, of the sand, silt, mud, and other substances, to be lifted, and kept always moving, or united and incorporated with the running water, added to the friction of the bottom and sides of the channel.

The chance of any sewer keeping itself clean is dependent on four things,—namely, its capacity, its form, its fall, and the quantity and force of the water running through it. It is only from observation and experience, and the application of rules deduced therefrom, to the proportioning the capacity, the form, and the fall, as also the quantity and force of water requisite to prevent deposit, that we can hope to arrive at perfection in sewerage. From observation and experiment, I find that it requires a constant velocity of current to be running through the sewers equal to about $2\frac{1}{2}$ feet per second, or $1\frac{3}{4}$ mile per hour, to prevent the soil from depositing within them.

There is less water running in the sewers on Sundays than on other days of the week; and most on Saturdays. The height of the flow every day goes on increasing from an early hour in the morning until about noon, when it is highest; it then gradually subsides to its lowest level. The period of the greatest flow every day is between 11 a. m. and 1 p. m.

The fall of sewers should be proportioned to the quantity of water that is to pass through them. For, with the same fall, the greater the body of water the greater will be the velocity and scour; and conversely, the less the body of water the less will be the velocity and scour. Again, a large body of water will, with a little fall, run with the same velocity as a small quantity will with a great fall. Hence the recipient of many branch sewers may have less fall than the branches themselves. A fall of a quarter of an inch in 10 feet has been considered the least fall that should be given to branch and summit-level sewers; but this fall is not enough to keep the sewers clean. No; such sewers should, in my opinion, have not less fall than half an inch in 10 feet. In some districts it is found impossible to get even so much fall as a quarter of an inch in 10 feet. In districts where proper fall cannot be obtained, it is necessary to resort to flushing to keep the sewers free of deposit and clean.

When a main stream receives a branch stream, the united body of water causes the height of the main stream to increase, consequently the surface rises somewhat higher than the surface of the divided streams; hence the water flows back, producing deposits of heavy substances about the junctions, which deposits draw back and impede the flow of the two streams. Now, in order to remedy this evil, the bottom of the main sewer, immediately below the junctions should be made some inches deeper than the bottoms above the junctions. By this mode of forming the bottoms, the surface of the main and branch streams will have a uniform inclination, and the acceleration of this fall will prevent regurgitation and deposit, and the united streams will flow onwards with increased speed.

In order to determine the depth below the junctions, it is necessary to calculate what height the body of water falling from the branches will increase the stream in the main. The capacity of the united stream is very much less than the sum of the capacities of the divided streams, and the velocity in the former is considerably greater than either of the latter. The ratio of increase of velocity follows the ratio of decrease of capacity. It follows, therefore, that a gradually accelerating velocity takes place immediately below the confluence of the sewers throughout the ramified system from their sources to their outfalls, and such I have found to be the case.

Egg-shaped sewers, varying in capacity according to the area, the number of houses to be drained, and the quantity of water to be discharged, from 9 inches wide by 1 ft. 3 in. high, to 1 ft. 6 in. wide by 2 ft. 6 in. high, would suffice for sewers on summit levels, and also for branch or collateral sewers which had to receive the drainage of from one to twelve or more ordinary-sized streets. Of course the secondary mains which would have to carry off the water from these branch or collateral sewers, as well as the principal main lines into which the secondary ones would discharge themselves, must be larger in proportion; but under a proper arrangement, fewer principal lines would be required.

Instead of discharging a large body of water uselessly, as to any power of sweep, I would, under the system of constant and concentrated supplies and smaller sewers, economise the water by using it to scour several small sewers instead of one large one. For this reason I would prefer having more outlets, or at least more catch-water sewers, instead of discharging all the drainage by one large main sewer throughout, although at or near the outlet, I might probably be obliged to lead the whole of the water into one main line; but I should not like to part with it into a main line until I had made it serviceable in sweeping as many sewers as possible. As the keeping of all sewers thoroughly washed out is necessarily dependent upon an abundant supply of water, the principle which I have thought it best to follow for that purpose is to tie and connect all the sewers together upon a uniform system of levels so as to use the water running along sewers on high levels for washing out those on low levels. For this purpose, as will be seen by the plans, (Plate V., figs. 2, 3, and 4), I would connect the heads of adjoining sewers below with the superior sewers above them, and arrange the connections so that, as the currents of water running along the latter sewers arrive opposite the connections, they may divide and subdivide themselves by the ridges or groynes formed by the meeting of the inverts. By this means the water would traverse from one sewer to another, and so keep up a perpetual flow throughout the entire system. There can be no doubt that with much smaller sewers than those now in

use, and a more regular and abundant supply of water, the sewers would, by this system of arranging them and economising the currents, keep themselves thoroughly clean.

All head sewers, from want of backwater, have a tendency to choke up, and their ventilation is also very bad, consequently there should be as few of them as possible.

The general surface of the metropolis, on the north side of the Thames, is most admirably situated for being efficiently drained, as the ground continues to rise with an easy acclivity from the river to the hills some miles to the northward. The surface is divided into several natural areas, each of which has its main outfall sewer running through the lowest level of the valley, and discharging into the Thames, and into these main or valley sewers the whole of the sewers on the sides of the declivities discharge themselves. This mode of drainage is a very objectionable one, and should never be resorted to if it be possible to avoid it. The declivities of all natural areas are generally in two directions, namely, transversely towards the valley line, and longitudinally towards the outfall. Now, if attention be paid to the levels, and the sewers on the sides of the declivities be judiciously arranged, a perpetual circulation of water may be kept flowing throughout the whole of them from the sewer on the summit at the head of the natural area to the outfall in the river; that is to say, a system of collateral or concentric sewers should rise one above another from the valley line to the ridge or water-shed line of the district; each collateral sewer skirting the entire area, and discharging itself into the river by a separate outlet, or in the manner previously referred to. It will be seen that, when the sewers running transversely are connected at their upper and lower ends on the same levels with those running longitudinally, a facility is afforded for the drainage to circulate from the highest sewer to the one immediately below, from this to the one next lowest, and so on throughout.

Mr. Phillips proposes fourteen graduated forms of branch secondary and principal main lines of sewers of the egg-shape for the drainage of a district in which the sewers and the water supply are under one and the same authority. Fig. 13, Plate V., shows the form of one of the sewers together with the radii of the several curves.

No.	Height.		Width.		No.	Height.		Width.	
	ft.	in.	ft.	in.		ft.	in.	ft.	in.
1	6	8	4	0	8	3	9	2	3
2	6	3	3	9	9	3	4	2	0
3	5	10	3	6	10	2	11	1	9
4	5	5	3	3	11	2	6	1	6
5	5	0	3	0	12	2	1	1	3
6	4	7	2	9	13	1	8	1	0
7	4	2	2	6	14	1	3	0	9

Much caution is required in the building of sewers in a clayey soil; otherwise, from the treacherous character of this ground—its liability to expand and slip,—the sewers may be forced in. The thickness of a sewer should be proportioned to the nature of the ground and the pressure it has to bear; but its stability is very much dependent on the goodness of the workmanship. A half-brick sewer, under ordinary circumstances, will, if executed well and soundly, the joints made thin, and the sewer worked true to the curve, be quite strong enough, and would be found to answer every required purpose. The thicknesses depend upon the material and strata. The equilibration may be altogether destroyed by a want of uniformity in the working of the curve. The greatest pressure of the ground acts laterally from the sides downwards. Much of this pressure may be prevented by leaving in the trench from the surface downwards short lengths of earth, say of 10 to 20 feet, and about 50 to 80 feet apart, to be tunnelled through for the sewer to pass. These benchings, as they are termed, will keep the sides of the trench from sinking and slipping, and so from pressing against the sides of the sewer.

The smoother the surface the less will be the friction, and consequently the greater will be the velocity and discharge; and the friction in a glazed pipe must be considerably less than in a brick drain, as commonly built. I am not prepared to say that the friction would be diminished so much as one-third; I think not so much. The smoothest glass pipes throw off transverse motions which greatly impede the flow. There is a difference in the flow of pure clean water and of sewage water; the latter moves more sluggishly. This is caused by its being *thicker* and more viscid, from having matter chemically combined and mechanically suspended in it.

As the velocity increases, so does the transverse section of the area occupied by the stream decrease. This is a natural law observable in all moving streams, for we see that in a moving mass of water the discharge is the same, whatever form and size the channel may assume, the velocity being greater where the channel is narrow and deep, and less where it is wide, flat, and irregular; but the exact ratio of decrease of area, from decrease of friction and increase of flow, can only be determined by actual experiment and by taking into account all the attendant circumstances which influence and govern the motion of the stream.

Have you at all considered the capacities of sewers necessary for draining different areas of ground?—Yes, I have given the subject much attention. If the consideration of the sizes of sewers was confined solely to the carrying off the water supplied by the several water companies, then I apprehend that pipes somewhat larger in size than the supply-pipes themselves would suffice; but provision has to be made for receiving and conveying away the waters of heavy rains. In London continuous heavy falls of rain are not of long duration, lasting seldom more than from one to four hours. About one-fifth of the quantity that falls is absorbed partly by the dryness of the surface of the roofs, the paving, and the ground, and partly by the porosity of the ground itself. A farther proportion is also prevented from flowing to the drains and sewers at all by hollows in the surface, and again reascends into the atmosphere as vapour. There is also a small quantity that enters into the composition of animal and vegetable bodies. Then there is the resistance the flow experiences from the friction of the entire surface, being accelerated or detained in proportion as the surface is more or less inclined. To provide for the discharge of a fall of rain of two inches in depth has been considered by Mr. Hawksley, C.E., the extreme datum upon which to proportion the capacities of town sewers generally. Now I believe that, practically, the sizes in his table, although they may appear theoretically correct, are (excepting for the smallest sizes) too large for sewers in London. It is extremely violent rains alone that produce a depth of two inches per hour, and such rains occur only once in four or five years, if so much. I am of opinion that it is unnecessary to proportion the sizes of the sewers to meet an extraordinary occurrence that may probably happen only once in so many years. My reason for not fearing any serious damage from an excess of rain at remote intervals being provided for in surface channels, excepting, perhaps, in situations peculiarly liable to inundation (for instance, at the foot of a long or steep declivity, or where the waters may, from any cause, be suddenly congregated at one focus) is, that I have observed, that in towns entirely destitute of underground drains, no such inconvenience is felt as would justify the formation of enormously large sewers, or the expenditure of large sums of money to provide against it. In August 1846, a most extraordinary fall of rain occurred in London. The storm lasted nearly two hours, and from the best information I have been able to obtain, the depth of rain amounted to about four inches. Much damage resulted therefrom, by the water in the principal main lines situate in the valleys flowing up the drains and branch sewers, and inundating the rooms and cellars below its level by the influence of its pressure. The inundation of lands and the damaging of property in the valleys could not happen if there were parallel catch-water lines of sewers on the sides of the declivities to convey the drainage into the river by separate outlets. The average fall of rain in London is about 22 inches in a year, or about $2\frac{1}{2}$ inches in depth per thousand hours. Now after observing and calculating the depths of different falls of rain in London, it appears to me that if the sewers were of sufficient capacity to receive and discharge, as fast as it falls, *a quantity of water equal to the produce of a fall of rain of one inch in depth per hour*, they would be found large enough, and that more particularly if they were built on the intercepting or catch-water principle, and so as to communicate with each other, and all be filled with running water at the same time. The steps to be taken to proportion the capacities of sewers to receive and convey away the waters of heavy rains should, I think, be as follow, although I fully admit our present knowledge of the subject to be very elementary:—

To ascertain the number of superficial yards or acres to be drained by each sewer separately; progressing in a uniform gradation from the entire natural area to be drained by the largest outfall sewer, to the small tract of land to be drained by the least sewer on the summit. Taking the hourly fall of rain, therefore, upon one acre at one inch in depth, we must provide for the discharge of a quantity of water ($\frac{43560}{12}$) = 3630 cubic feet per hour, or one cubic foot nearly per acre per second. Then taking into account the loss

from absorption, the detention from friction, and otherwise, that quantity might be reduced to four-fifths of a cubic foot, but as the carrying off the waste water of the entire of London must be provided for at the same time, one cubic foot may, I think, be considered as the datum upon which to calculate the capacities of sewers sufficient for conveying away that quantity of water per second multiplied by the number of acres to be drained. The quantity of rain-water draining from an acre of ground in one second of time may be determined by first ascertaining the exact area of surface drained by some large main sewer; and, secondly, during the time of the storm, the quantity of water passing through the sewer in one second; then the number of cubic feet of water discharged, divided by the number of acres drained, will give the number of cubic feet of rain draining from the surface of each acre per second.

The area of surface that a sewer will drain, and the quantity of water that it will discharge in a given time, will be greater or less in proportion as the channel is inclined from a horizontal to a vertical position. The ordinary or common run of water in each sewer, due from house drainage alone, and irrespective of rain, should have sufficient velocity to prevent the usual matter discharged into the sewer from depositing. For this purpose it is necessary, as I have previously observed, that there should be in each sewer a constant velocity of current equal to 2½ feet per second, or 1¾ mile per hour. The inclinations of all rivulets, brooks, streams, and rivers gradually and proportionally diminish as they progress from their sources to their outfalls. In proportion as the inclinations diminish so does the quantity of water increase. If the inclinations were the same throughout, the velocity of the united stream at each confluence would increase in nearly the same ratio as its quantity, or equal to the sum of the previous velocities of the recipient and the feeder, and thus would the velocity ultimately become so very impetuous as to tear up and sweep away the materials of its bed, and cause destruction along its banks. If the force of the waters of the river Rhone were not absorbed by the operation of some constant retardation in its course, the stream would have shot into the Bay of Marseilles with the tremendous velocity of 240 feet in a second, or 164 miles every hour; and even if the river Thames met with no system of impediments in its course, the stream would have rushed into the sea with a velocity of 80 feet per second, or 54½ miles in an hour. The result, however, of the operations of nature is a compensation for the increased body of water by a diminution of the inclination of the bed, and so an economising of the force of the gradually accumulating current. The inclinations of the sewers of a natural district should be made to diminish from their heads to their outfalls in a corresponding ratio of progression, so that as the body of water is increased at each confluence, one and the same velocity and force of current may be kept up throughout the whole of them.

In some situations I would build side entrances to a tubular system of sewers; but I believe their use, in some degree, might be superseded. Means of access to the sewers, so as to be able to get at and remove accidental obstructions, would readily suggest themselves. A shaft, having a strong moveable grating on top, could be built over the sewer, with ladder-irons built in the angles, to admit a man to go down and up, with a recess at the bottom on one side to give room. This shaft may be also made to serve as a ventilator. (See figs. 5 and 6, Plate V.)

Gully Drains.—I have constructed gully drains with terro-metallic and glazed stone-ware pipes of 6 inches and 9 inches diameter, as shown in figs. 7, 8, 9, and 10. I was led to recommend the adoption of this mode of construction from the following causes:—In passing through the sewers I found lying opposite the vents of a large number of the gully drains heaps of stones, and all kinds of streets refuse, which it was utterly impossible for the water to remove. The dams thus formed caused the sewage to accumulate behind them, and the noxious effluvia evolved from the decomposing matter escaped into the streets by the gullies, and occasioned much of the annoyance felt by passengers. The best remedy for this evil appeared to me to be to prevent the stones and street refuse from passing into the sewers, t build the drains so that they would not choke up, and to prevent the emission of foul air from the sewers into the streets by the gullies. We have accomplished these things most perfectly, by reducing the width of the spaces to ¾ inch between the bars of the gully grates, by constructing the drains of the form shown by the section from the gully to the sewer, and by fixing at the vent an air-tight cast-iron valve or flap, hung with shackles, as shown in figs. 11 and 12. A grating of trellis-work or cullender is placed under the top grating, at the bottom of the box, for the purpose of catching small stones and rubbish that may pass between the bars of the grate above, and so to prevent them from falling into and choking up the sewers. I have not, as yet, made use of the lower grating, but probably, I should be induced to do so in connection with a tubular system of sewers, as it is important to keep large and heavy substances and refuse out of the drains and sewers. I may state that as a proof of the efficacy of the foregoing mode of constructing the gully-drains with the improved grate, the labour and expense of cleaning, not only of the gully-drains, but of the sewers as well, is now, comparatively speaking, nothing compared to what they used to be, and I confidently entertain an opinion that the labour and expense will be still less and less."

Mr. Phillips has just produced his report on the improvement of the drainage of Westminster, and which has been printed. This document is of great importance, and we are pleased to see that most of our suggestions on this subject have been adopted, particularly with reference to turning part of the drainage into the Regent Street Commissioners' Sewers. Mr. Phillips proposes to divert the high level streams to a station at the east end of Duncannon-street in the Strand, to bring the Westminster drainage to the same station, and to apply the natural power thus to be obtained to work two water-wheels of the most approved construction, with revolving buckets and plunger-pumps attached, to lift the drainage from the well or receiving reservoir below, and discharge the same into channels communicating with the upper stream on a level with high water, beyond the tail of the wheels. The sewage will then be carried under the side-bed of the river into low-water stream.

Below we give a summary of Mr. Phillips' estimates, which make a total of £28,874 14*s.*

Summary of the Estimates.

Feet Run.	Class No.	Internal Diameter.	Sectional Area.	Price per Foot.	Totals.
		in. in.	feet	s. d.	£ s. d.
8,118	1	50 × 30	8·19	14 0	5,682 12 0
4 524	2	40 × 24	5·23	10 0	2,262 0 0
2,086	3	30 × 18	3·64	6 0	625 16 0
9,599	4	20 × 12	1·31	4 6	2,159 15 6
18,709	5	17½ × 10½	1·	4 0	3,741 16 0
53,284	6	15 × 6	0·73	3 3	8,658 13 0
7,699	7	12 × 7½	0·56	2 6	962 17 6
9,742	8	9 × 6	0·29	2 0	974 4 0
113,761		(=4*s.* 5*d.* per foot run, nearly.)			£25,067 14 0

Estimate for building a GULLY DRAIN, average length 20 feet.

	£ s. d.
Six cubic yards Digging, &c., at 1s. 6d.	0 9 0
Twenty feet run of 4 in. Pipe, at 8½d.	0 14 2
Gully Grate (about 1½ cwt.) including bedding and fixing	0 16 0
Total	£1 19 2

About 400 Gully Drains will be required, which at, say 2*l.* each, amounts to £800 0 0

Estimate for building a SEWER along Pall-Mall-East, Trafalgar-square, Duncannon-street, Strand, and Villiers-street, for diverting the Western and Eastern branches of the Hartshorn-lane Main sewer,—being a length of 2,230 feet, at 18*s.* per foot £2,007 0 0

Estimate for TWO WATER WHEELS, with complete Lifting Machinery attached, and including all necessary work.

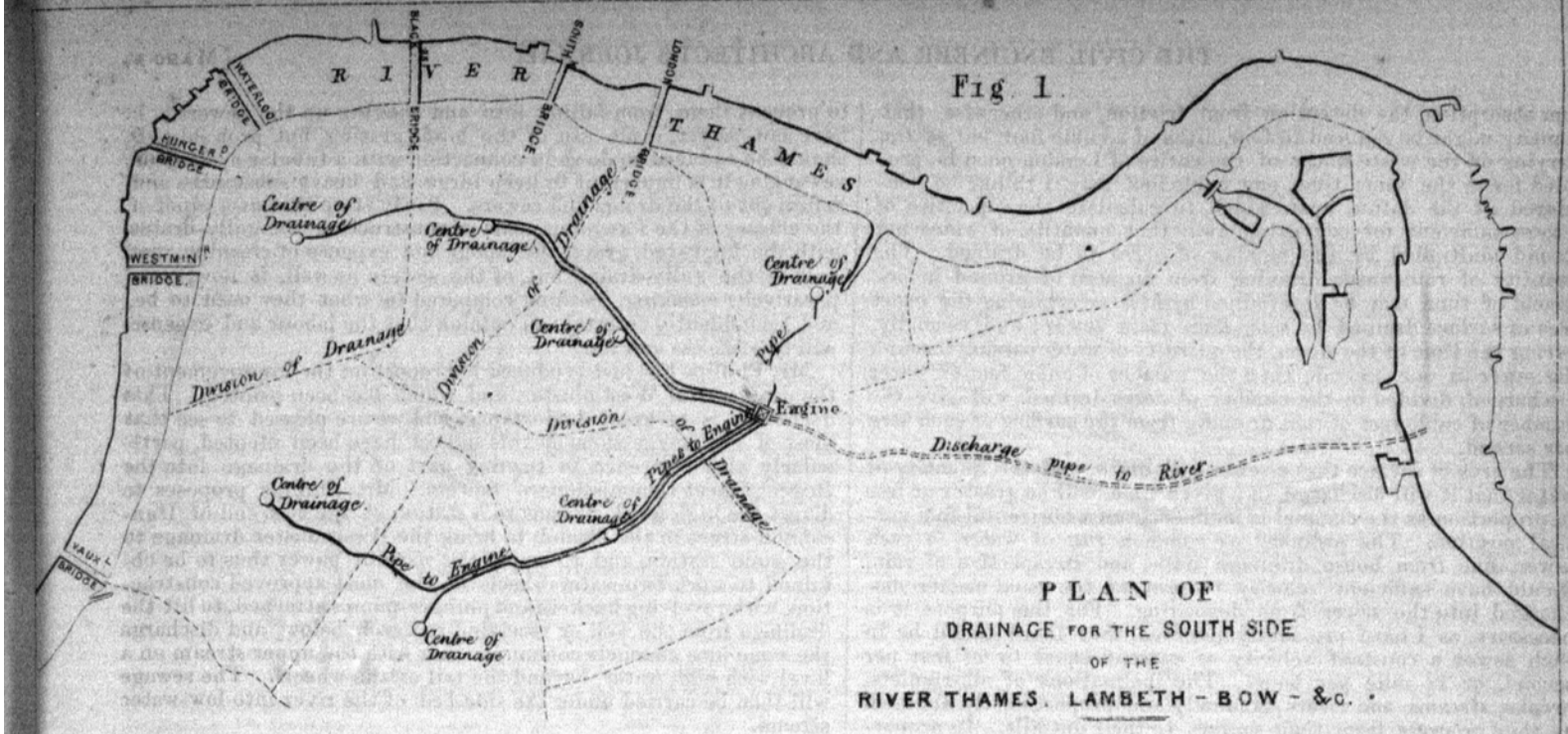
	£ s. d.
Brickwork—say 40 rods at 10*l.*	400 0 0
Two Water Wheels, at 200*l.*	400 0 0
Lifting Machinery—say	200 0 0
Total ..	£1,000 0 0

REFERENCE TO ENGRAVINGS, PLATE V.

Fig. 5.—Section of Shaft on A A.
Fig. 6.—Plan of Shaft.
Fig. 7.—Section of Gully Drain from Grating to Sewer.
Fig. 8.—Plan of Gully and Grating.
Fig. 9.—Transverse Section of Gully and Grating on A B.
Fig. 10.—Longitudinal Section of Gully and Grating on C D.
Fig. 11.—Section of Drain and Flap at Vent.
Fig. 12.—Front View of Flap.
Fig. 13.—Mode of Striking the Curves.

PLATE V.

Fig 1.



PLAN OF
DRAINAGE FOR THE SOUTH SIDE
OF THE
RIVER THAMES. LAMBETH - BOW - &c.

Fig. 2.

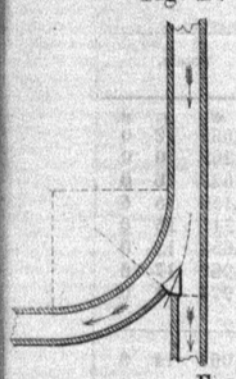


Fig. 3.

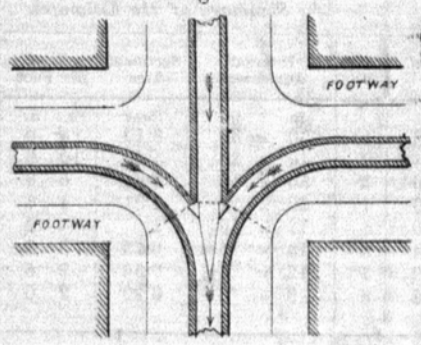


Fig. 4.

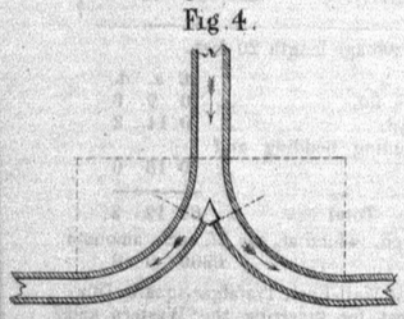


Fig. 7.

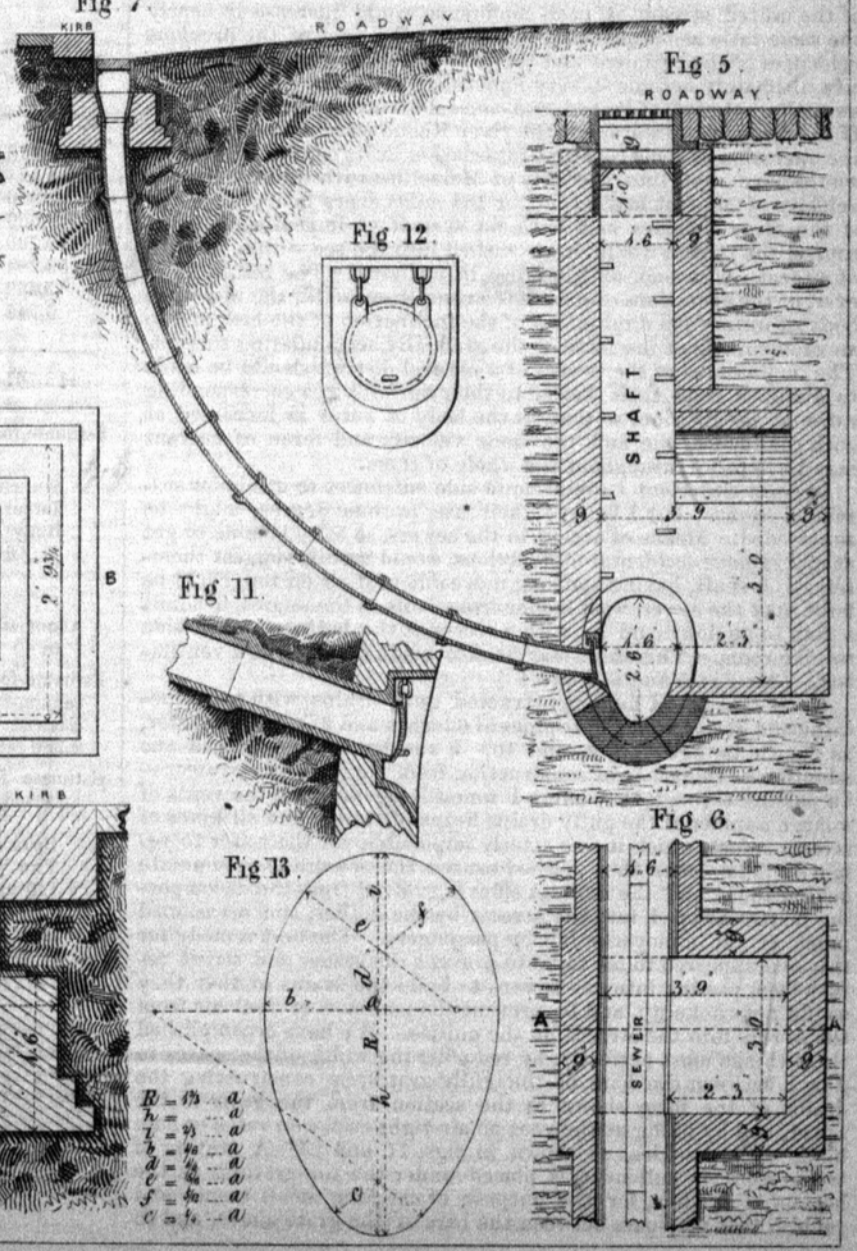


Fig 12.

Fig 5.

Fig 8.

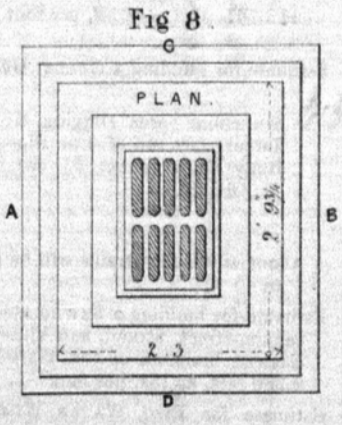


Fig 11.

Fig 6.

Fig. 10.

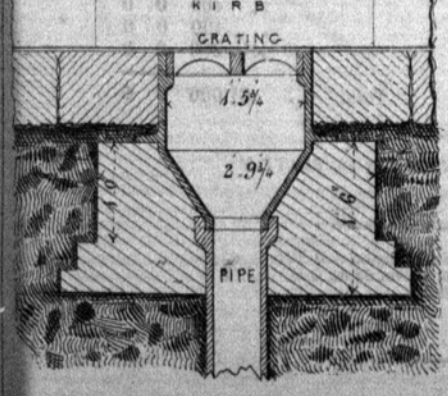


Fig 9.

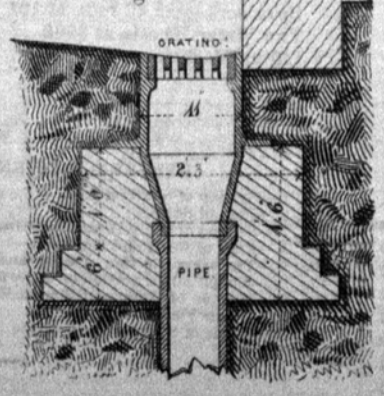


Fig 13.

ON THE MOTION OF WATER.—By Guido Grandi.

Translated by E. Cresy, Esq., *in his Evidence before the Metropolitan Sanitary Commissioners.*

Our author has taken considerable pains to construct a parabolic table, given in his work (Book 2, cap. 5); by a reference to which much labour will be saved by those who desire to make similar investigations; he thus describes it:—

"This table is divided into three columns. The first containing a natural series of numbers from 1 to 1800, representing equal parts, as inches or other measures. These numbers are the heights from which the water falls. The second column contains the roots of the opposite numbers in the first, and expresses the velocity of the water, corresponding to the height in the first column, in integers and decimals: when the root is somewhat greater than the truth, the sign + is prefixed, and when less −. The third column contains the product of the first and second, and must be read off as exceeding or falling short of the truth, according as the sign + or − is prefixed to its second factor.

It is clear that if the numbers of the first column express the height of a parabola, the numbers in the second will be its ordinates when its *latus rectum*, or parameter, is 1; or at least, they will be proportional to the ordinates in subduplicate ratio of unity to the *latus rectum* of a given parabola, and the numbers in the third column will be the rectangles circumscribing the parabola which has unity for its *latus rectum*, and will be moreover proportional to the area of the parabola, which is always $\frac{2}{3}$rds of the circumscribing rectangle.

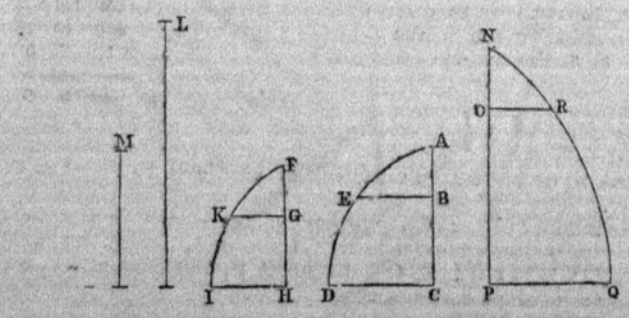
If the parabola has $2\frac{1}{4}$ for its *latus rectum* in terms of the first column, all its ordinates are to the ordinates of the parabola of the same height, having 1 for its *latus rectum*, in subduplicate ratio of $2\frac{1}{4}$ to 1, that is, as $1\frac{1}{2}$ to 1, or as the circumscribed rectangle to the parabola, it is clear that the parabola whose *latus rectum* is $2\frac{1}{4}$ will be equal to the rectangle which circumscribes the parabola whose *latus rectum* is unity; but such a rectangle is equal to the product of the base by the height, which is the number opposite in the third column, therefore the numbers in the third column express the area of a parabola whose *latus rectum* is $2\frac{1}{4}$, and is proportional thereto when the *latus rectum* is any other quantity.

Moreover, since the numbers in the first column express the height of water standing in a vessel, or the distance of each particle of running water above its base, and the numbers in the second column representing the velocity caused by such a height, the numbers in the third column express the quantity of water which will issue through such a width in a given time, through a hole or section whose height would be equal to the whole distance from the surface of the water or origin of the river, and the base of such a section as the number in the first column.

The difference of numbers of the third column will be the quantity of water which escapes in an equal time through a hole or section of equal breadth, and of a height equal to the difference of the corresponding numbers of the first column.

By adding two or more numbers together of the third column we shall have the sum of the quantity of water carried in a given time through several canals of the same width, whose sections correspond to the numbers of the first column; and in the aggregate of such numbers, or the nearest thereto, in the third column will correspond to that number in the first, which indicates a height capable of comprising the channels united, as will be better understood by the following examples:—

1st. Given two streams, the breadth of the first of which is L = 760 feet. The velocity of the surface B E corresponding to the fall A B of 1 foot (which, according to Guglielmini's table is equivalent to 216 feet 5 inches per minute, that is, $3\frac{4}{5}$ feet in a second, or $2\frac{3}{5}$ miles per hour), the height of the surface B C = 30 feet, whence A C 31 feet; then the whole parabola A E D C, according to the third column of our table opposite 31 feet, will be found 7175·88, from which subtracting the parabola A E B, which is found in our third column to be 41·52, the parabolic trapezium B E D C will be 7134·36, and this will be the scale of the velocity of the section B C, which multiplied by the breadth L gives a quantity of water = 542211360.



The second stream having a width M = 139 feet, its superficial velocity will be G K, depending on the height F G, 8 inches (which gives, by Guglielmini's table, a velocity of 176 feet in a minute, rather less than 3 feet in a second, and 2 miles 56 perches in an hour). The height of its surface G H is 11 feet, and consequently F H 11 feet 8 inches, corresponding in our third column to the value of 1656·20 for the parabola F K I H, from which subtracting the parabola F K G, which our table gives opposite 8 inches as 22·64, there remains the trapezium G K I H 1633·56, which is the scale of the velocity of the second stream, which, multiplied by the width M, gives the quantity of water passing in a given time through this river = 227064·84; whence the two quanties carried by both the rivers will be 5649178·44. Supposing they flow together, without increase of velocity, B E = O R; and let the height O P, at which the united water runs, be the unknown quantity, then since O N = B A through R, and with the axis N P, describe the parabola N R Q P, the truncated parabola O R Q P will be the scale of the velocity of the united rivers, which multiplied by L = the sum of the two quantities = 5649178·44, which divided by L gives a quotient 7433·13 = the parabolic trapezium O R Q P, and adding the parabola N R O = 41·52, we shall have the parabola N R Q P = 7474·65, the nearest number to which in the table is 7464·28, corresponding to a height of 31 feet 10 inches. This number sought being rather more than the tabular value, it will be found by proportional parts that $\frac{1}{3}$ must be added. Therefore N P = 31 feet $10\frac{1}{3}$ inches and O P = 30 feet $10\frac{1}{3}$ inches; therefore the union of the streams raises the level B C $10\frac{1}{3}$ inches.

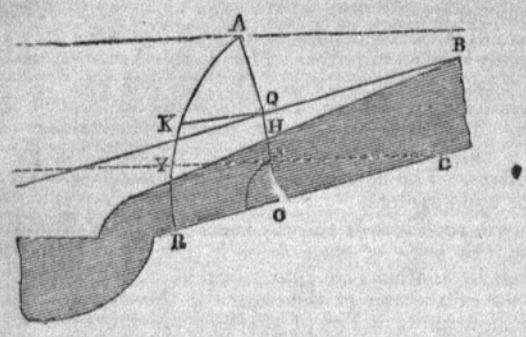
But if, at the conflux of the rivers, the velocity B E augments, becoming O R, so that the height N O depending on it exceeds A B by 1 inch, the parabola N O R, corresponding to a height of 13 inches, will equal 46·93, which, added to the trapezium R O P Q, found previously to be 7433·13, we shall have the total parabola N R Q P = 7480·06, the nearest number to which, 7464·28, corresponding to 31 feet 10 inches; but since this is rather too little, we must add $\frac{1}{2}$ for the proportional part of the difference, whence N P = 31 feet $10\frac{1}{2}$ inches; from which N O = 1 foot 1 inch being subtracted, there remains O P = 30 feet $9\frac{1}{2}$ inches, making the total increase in this case $9\frac{1}{2}$ inches.

But if we suppose with Guglielmini, and which is not improbable according to actual observation, that the scale of a velocity in a given section is an entire parabola and not a truncated one, the velocity, as in the case of vessels depending only on pressure, whence the surface alone acquires velocity when it is communicated by the lower water which transports it, the calculation will then be more quickly effected. Wherefore A C = 30 feet, the height of the first river, and F H = 11 feet, height of the second. The parabola A E D C = 6829·20, in our table, which, multiplied by the width L 760 feet, gives for the quantity of water 5190192·00, and the parabola F I H = 1516·68, which multiplied by the width M = 139 feet = 210818·52, whence the sum = 5401010·52, which, divided by the width L, gives, when the velocity of the surface is not increased, the parabola N Q P = 7106·59, corresponding to a height of 30 feet 10 inches, corresponding in the table to the number 7118·80, which is rather more than the preceding; wherefore the rise will be 10 inches.

Then if the velocity of the two rivers increases at their confluence, the height will be reduced in the reciprocal ratio of that velocity; so that if the velocity be increased $\frac{1}{100}$, the height will be reduced to $30\frac{1}{2}$ feet, that is, the increase will only be about 6 inches; if the velocity increases $\frac{1}{25}$, the height will be 29 feet 8 inches; so that the height, in place of increasing, will actually be reduced about 4 inches by the union of the two streams; so likewise the height 30 feet, will remain precisely the same when the velocity is increased by $\frac{1}{36}$, since 37 : 36 :: 30 feet 10 inches : 30 feet.

Example 2.—The influent C B D R in a given point of its bed has the height O H, having a free influx into the recipient R M, when it is low, and its superficial velocity in H is what would correspond to a height A H of 4 feet. Then, raising the level N S of the recipient, regurgitation follows through the level of the influent. It is required to find the increase in the height O H = 7 feet? Suppose it to increase as far as Q, draw the parabola A K R, with its ordinates H Y, Q K; let O S, cut off by the prolongation of the level of the recipient, = 3 feet; the whole height A O will

be 11 feet, and by the table the parabola A O R = 151668; the other, A H Y, 4 feet high, will be 332·64; whence the trapezium H Y R O will be the scale of the velocity, and the quantity of water passing in a given time through the section H O = 1184·04. If the parabola S P O be 3 feet high, its value in the table = 216·00; then the parabolic trapezium Q K Y H, being equal to the aforesaid parabola S P O, will be 216·00, which substituted from the total value of A H Y, there remains the parabola A Q K = 116·64.



This number not being precisely to be found in our table, find the next highest, = 117·60, which corresponds to a height of 2 feet; whence we arrive at the conclusion that the regurgitation at the point O has raised the water 2 feet more than the first, supposed to be 4 feet."

To facilitate the practical application of the principles contained in Grandi's proposition, the following rules will be found convenient:—

The height and width of the section of both the influent and the recipient being given in each case and their velocity being equal.

1. When the velocity of the united streams is the same with that of each separately, to find the increased height of the united section.

Find in the table the parabolic value in the third column corresponding to the given height of the recipient in the first. Multiply this value by the given width. Perform the same operation for the influent, we shall then have obtained the quantity of water brought down by each. Add these two quantities together. Divide their sum by the width of their united section, which may be either that of the influent, or of the recipient, or greater or less than either. Find the quotient obtained by such division in the third column of the table, opposite to it in the first will be found the height of the united sections.

2. When the velocity of the united streams is increased, to find the height of their united section.

Divide the height found by the preceding rule by the number of times by which the velocity is increased, the quotient is the height of the united sections.

3. When the velocity of the united streams is diminished, to find the height of their united section.

Multiply the height found by our first rule by the number of times by which the velocity is diminished, the product gives the required height.

4. When the height of the united streams remains the same, to find their increased velocity.

Divide the height as found by the first rule by the original height, the quotient will give the increased velocity.

5. When the height of the united streams is increased, to find their velocity.

Divide the height found by the first rule by the increased height, the quotient gives the diminished velocity.

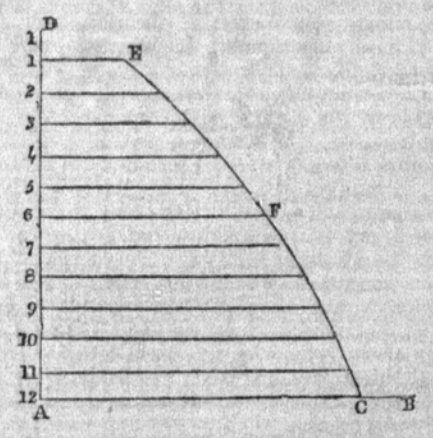
6. When the height of the united streams is diminished, to find their increased velocity.

Divide the height found by the first rule by the diminished height, the quotient will be the increased velocity.

To exemplify these rules a small table is subjoined, constructed from Grandi's data, that is, supposing a stream 760 feet wide and 30 feet high to receive successively 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, similar influents. The first column contains the number of influents; the second, the height caused by the addition of these successive streams as calculated by our first rule, that is, supposing the velocity to remain the same; the third column shows the increased height found by Genneté, the original height, 30 feet, being here increased by the addition of $\frac{1}{49}$, $\frac{3}{49}$, $\frac{4}{49}$, &c. The fifth column shows the increased velocity requisite to produce the height shown in the third; thus supposing a stream 760 feet wide and 30 feet high to receive two other similar streams, the increased height, according to Genneté, will be 30 feet 7·6 inches, and to produce such a height the required velocity will be 1·97233. Either of these numbers is deducible from the other by one of the preceding rules; thus, supposing the height 30 feet 7·6 inches to be given, and the velocity to be required, by Rule 5, dividing 62 feet 4·6 inches by 30 feet 7·6 inches we obtain a quotient of 1·97233. Supposing, on the other hand, the velocity 1·97233 to be given, we obtain the height by Rule 2, since 62 feet 4·6 inches ÷ 1·97233 = 30 feet 7·6 inches. The fourth column shows the increased velocity required to maintain a constant height of 30 feet, and is found by Rule 4.

No of Streams.	Increased Height for a Constant Velocity.	Height as given by Genneté.	Velocity to maintain a Constant Height.	Velocity to produce Genneté's Height.
	Ft. In. '	Ft. In. '		
1	30 0 0	30 0 0	. .	. .
2	47 7 6	30 3 9	1·58475	1·34203
3	62 4 6	30 7 6	2·07916	1·97233
4	75 8 0	31 3 0	2·52222	2·42133
5	87 8 0	31 10 6	2·92222	2·75032
6	99 1 0	32 6 0	3·30277	3·04897
7	109 10 0	33 1 6	3·66111	3·31572
8	120 0 0	33 9 0	4·00000	3·55555
9	129 9 0	34 4 6	4·32500	3·77454
10	139 2 0	35 0 0	4·63888	3·97618
11	148 5 0	35 7 6	4·94722	4·66081
12	157 3 0	36 3 0	5·23333	4·33793

It is found that the several increments of either height or velocity are as the ordinates of a parabola whose axis is divided into the same number of parts as there are required velocities. Hence an elegant method of finding the intermediate heights or velocities when the two extremes are given. Suppose, for example, we require to find the several heights indicated in our first column. Find the height required for twelve streams by our Rule 1. Draw A B, and from a scale of equal parts set off 157 feet 3 inches from



A to C, at A erect a perpendicular A D to A B, and set off twelve equal parts thereon, and draw through the points 1, 2, 3, &c., lines parallel to A B, on the parallel I E, set off the first height 30 feet from the same scale as A C. Then by Rule 1 find the height of any one of the intermediate streams, as 6, and set it off from 6 to F, then through the points E, F, C, describe a parabola, the portion cut off on each ordinate by the curve will be the several numbers given in the table as measured by the scale from which I E, 6 F, and A C were taken; the abscissæ 1, 2, 3, &c., may be set off by any scale, providing they are equidistant, and according as they are wider or narrower, will the parabola increase or diminish its curvature. It is evident that in the case of 100 additional streams the labour of calculation will be materially shortened, as no more than three values need ever be found arithmetically.

In like manner either of the other values shown in our table may be represented parabolically. Column 5, for example, by setting off 1·34203 on I E, 4·33793 on A B, 3·04897 on 6 F, and describing a parabola through those points.

BLACKWALL RAILWAY MACHINERY.

Description of the Machinery erected by Messrs. Maudslay, Sons, and Field, at the Minories Station, for working the London and Blackwall Railway. By ANDREW JOHN ROBERTSON.—(Read at the Institution of Civil Engineers).

The London and Blackwall Railway is about $3\frac{3}{4}$ miles in length, and is worked by stationary engines of the estimated force of 448 H. P. and 280 H. P.,* at the London and Blackwall termini respectively: the carriages being attached by grips to a rope, which is wound off and on to large drums situated at each extremity of the line. The greater power is required at the London station, in consequence of there being a total rise in the railway, in this direction, of between 60 and 70 feet (average 68 feet); the steepest inclination being 1 in 100. There are seven intermediate stations on this line; the Poplar, West India Docks, Limehouse, Stepney, and Shadwell stations, communicate with the Fenchurch-street terminus; whilst those of the Minories, Cannon-street, Shadwell, and Stepney, communicate with the Blackwall terminus. This arrangement is effected by appropriating a separate carriage from the termini for each intermediate station, communicating with the same; these are detached whilst the trains are moving, and by means of breaks they are stopped at their respective destinations; as soon, however, as the terminal train arrives at either end of the line, and the rope ceases its motion, these intermediate carriages are attached to the rope, whilst it is in a state of rest; so that when the engines are again started, the carriages are also simultaneously set in motion, and arrive successively at the termini, in the order and at intervals corresponding with the position of the places from which they started; as they arrive they are released from the rope, though in motion, by the sudden withdrawal of the grip iron, and then their momentum carries them forward to their proper places in the station. It will be perceived, that the intermediate traffic is by this means provided for, without causing any detention to the through trade.

The peculiar mode of working the line, and the circumstance of so many carriages being attached to the rope at different places, rendered it absolutely necessary to provide some quick and certain system of signals between the termini and the intermediate stations. These objects being deemed attainable by means of the electric telegraph, that system was adopted, although it was of greater extent than any which had been previously tried, and it was executed by Mr. Cooke, one of the patentees. The telegraphic wires are inclosed, for security, within welded iron pipes, with screwed joints like gas pipes; there is a duplicate set of such wires and pipes, in case of one set being accidentally fractured. One pipe runs along each side of the railway throughout its length.

The machinery at the London end, for working the railway, is situated at the Minories station. The carriages in coming towards London are disconnected from the rope, a little before they arrive at the Minories, and they perform the rest of the journey to the terminus in Fenchurch-street by their momentum. The upward inclination of the rails at this place is 1 in 150.

When the down-train leaves the terminus in Fenchurch-street, it descends the incline to the Minories by its gravity, where it is stopped by the breaks, to allow of the passengers being received at that station, and to permit the attachment of the rope; there the train remains for a short time, until signals have been received by the electric telegraph, from each of the intermediate stations, that the carriages are ready for starting, and are properly attached to the rope, in the manner already described. It being thus known at the Minories that all is ready, the signal for starting is sent from thence to Blackwall; the engines there are then put in motion and begin to draw the rope with all the carriages towards Blackwall.

At the same time that the down-train leaves the Minories, the up-train leaves Blackwall, the arrangements being similar to those above described. The train runs by gravity from the Blackwall station to beyond the engine-house, where it is stopped by the breaks, in order to attach it to the rope, and as soon as signals have been received at Blackwall, from each of the intermediate stations, that all is ready, the signal for starting is sent from Blackwall to the Minories, and the engines there are put in motion, and begin to draw the rope and all the carriages towards London. The machinery at the Blackwall end is situated a little way along the line from the terminal station; the distance from thence to the place where the carriages going to Blackwall are disconnected from the rope, being somewhat farther from the station than the engine house, and the carriages run that distance by momentum, in the same manner as at the London end; the rise towards the Blackwall station being there also 1 in 150. During the winter the railway is worked from half-past eight o'clock in the morning until nine at night; and in the summer, from eight o'clock in the morning until ten at night. A train leaves each end every quarter of an hour (giving in winter 51 trains, and during the summer 57 trains per day). The whole time occupied in passing between the termini is thirteen minutes; but the engines are at work only from eight to nine minutes. The engine-house at the Minories is situated beneath the railway. It is 48 feet long by 72 feet wide, and the extreme length, into the recess in front of the drums is 69 feet. The rails are carried over the machinery on cast-iron girders, which are supported at two intermediate points by cast-iron pillars. The flooring over the engine-house is carried in like manner upon girders.

Beneath each line of railway there is a large drum for the rope, and on the axes of each drum is a mortice spur-wheel, which is driven by another iron spur-wheel of larger diameter, on a prolongation of the axis of the cranks of the steam engines; the prolongation forming a line of shafting which extends all across the engine-room, with a pair of engines at each of its extremities. Only one pair of engines is worked at a time, the other pair being disconnected at the cranks. Under ordinary circumstances, one pair is worked for about six weeks, and then the other pair for a similar period; the object being to secure the traffic from interruption, by having a duplicate pair of engines always ready to be connected at all emergencies and in case of any accident happening to the other pair, as well as to give time for the ordinary cleaning and repairing of that pair of engines which is not at the time in use. When one pair of engines is connected to the axis of the two larger spur-wheels, the other part must be disconnected from it. This is done by removing the pin of the crank on the extremity of the said axis, and also removing the drag-link, by which that pin is connected with the pin of the engine-crank, on which latter pin the connecting-rod is jointed. The rope on one line must be wound up round its drum, whilst that on the other line is allowed to unwind from off its drum, so that the two drums will revolve in contrary directions. The trains travel alternately backwards and forwards on the same line of rails, instead of one line of rails being always travelled over in one direction and the other line in the contrary direction, as is the case on other railways. For instance, if the first train in the morning goes down from London to Blackwall along the north line, the second train down in the same direction will go along the south line, and the third train down along the north line, and so on. One end of each rope is wound around one of the drums at the Minories, and the other end of the same rope around a corresponding drum at Blackwall; and whenever one of those drums is turned round by its engines for winding up that end of the rope, the drum at the other end of the same rope must be disconnected, and left free to turn round as the rope is pulled off it. This requires some ready means of disengaging either of the drums from the engines, which is done by withdrawing the pair of spur-wheels from each other until their teeth become disengaged. The plummer-blocks, in which the two ends of the axes of each of the drums revolve, are mounted on rollers, and are capable of being moved horizontally by screws, until the spur-wheels are out of gear. The two screws for the plummer-blocks of the same drum, are moved simultaneously by gearing, worked by a handle on the platform in the recess in front of the drums; so that a man by turning that handle, either connects or disconnects the gearing, as may be required.

The main axis upon which the two large spur-wheels are mounted, may be considered as a single axis, but is, in fact, two lengths of shaft, connected together by cranks and drag-links at the mid-length of the prolonged axes, which two lengths can be disconnected at pleasure, by removing the drag-links and crank-pins. Hence there are two sets of machinery exactly similar, and capable of being connected and disconnected in such manner, as to admit of either of the two drums being worked by either of the two pairs of engines, whilst the other drum is wholly disconnected; each line can thus be worked by either pair of engines, independently of the other line or pair of engines. The engines always revolve in the same direction, causing the drums to wind up the ropes around them; but when the drums turn round in a contrary direction for unwinding the ropes, they are disconnected from the engines. A wheel is attached to each drum for the purpose of being acted upon by a break, not only for stopping the motion of the drum, after the arrival and stoppage of the down-train at

* The nominal power of these engines is, 224 horse-power for each pair at the Minories; and 140 horse-power for each pair at Blackwall. There are duplicate engines at each station, making 448 horse-power at the Minories, and 280 horse power at Blackwall.

the Blackwall end of the line, but also for maintaining a suitable degree of tension on the part of the rope behind the train, whilst it is in motion. The object of keeping the tension on the rope is to prevent it from being unwound from off the drum faster than the train proceeds, and to secure the rope against the risk of breakage, to which it would be liable, if it were allowed to become slack and then to be suddenly tightened, by the acceleration which takes place in the motion of the train, after it has commenced the descent of a steeper gradient than that on which it was previously travelling.

The engines being only worked for eight or nine minutes out of every quarter of an hour, the vacuum in the condenser might during the remaining six or seven minutes become imperfect from leakage, or from air contained in the injection water; in which case the restarting of the engines would be difficult, except by previously blowing steam through the condenser, to displace the air,—for the greatest power is required at starting, when the machinery, he drums, the rope, and the train, have all to be set in motion from a state of rest, and there must be a good vacuum in the condenser to enable the engines to start promptly. For this object an engine of 12 horse-power is provided, and constantly works two auxiliary air-pumps, which maintain the vacuum in the condensers of the large engines, independently of the action of their own air-pumps.

In the arches upon which the railway is carried to pass over the engine-house, *eight water-tanks* are placed, all connected together by pipes. The overflow of waste water from the hot cisterns of the engines, is conducted from the usual overflow-pipe into the most distant of the eight tanks. From that tank the water passes into the next, and then to the next, and so on to the last of the eight tanks, in which it is mixed with fresh cold water, and the mingled water is then conveyed into the engine-room, for supplying the injection cocks of the engines. The surface of the water in the eight tanks is exposed to the atmosphere, and the hot water thus becomes cooled in passing through them. At first there were only three tanks, in which, as they exposed a large surface to the air, it was expected the cooling of the water would proceed with sufficient rapidity to render it fit for injection upon arriving at the third tank, and being there mixed with fresh cold water; but, as it was found that there was not a sufficient cooling effect, five more tanks were added, and the eight tanks now in use are scarcely sufficient for cooling the water to the extent required. The supply of cold water, for mixing with the water in the tanks, is pumped by the 12 horse-power engine from a well in the adjoining part of the building, and, in addition to this supply, a small pipe is laid on from the main of the New River Company. The temperature of the injection water in summer is about 80°, and often higher, and the vacuum then obtained is about 24 inches of mercury; in winter there is no difficulty as to the temperature of the water, and the mercury stands at from 27 inches to 28 inches. Each of the tanks is 24½ feet square and 6 feet deep, so that the capacity is 3,600 cubic feet, and the surface of water exposed is 600 square feet in each tank.

The steam-pipe from the boilers passes through the wall, and is carried inside the engine-room to the right and left to each pair of engines, with a valve-box, from which two branches proceed to supply each engine. The valve in the box is opened and shut by a screw, worked from below by a handle, by which the engineman regulates the speed of the engines.

The governor is placed beyond the outer frame of the pair of engines, and the number of its revolutions is to the number of strokes made by the engines as 3 to 2. It is worked from the crank of the engines by a pair of bevil wheels on a small axis passing through the outer frame. The governor acts upon a throttle-valve placed in the steam-pipe, immediately beyond the shut-off valve. The resistance the engines have to overcome varies so much, that the governor was found not to be capable by itself of regulating the speed, and therefore it was assisted by the man closing the shut-off valve by its screw handle; but latterly the governor has been disconnected, and is not now used.

To avoid snatching the rope, by which it might be broken, great care is taken to start the engines as gradually as possible, in order that all the slack of the rope may be gathered up around the drum, and then the train be started slowly, and gradually accelerated to the full speed. The valve is therefore only partially opened at first, and is afterwards opened fully by degrees; as the engines acquire speed, the valve is closed again gradually, to restrain the speed, as the carriages arrive one after another, and the resistance diminishes.

The Boilers.—The boiler-house is beneath the railway, the five boilers being placed under the arches on which the continuation of the railway is carried beyond the engines. Two of them are square marine-boilers, with the ordinary internal furnaces and rectangular flues; the other three boilers are constructed on the Cornish system, being circular, with two internal tubes through their entire length, and the furnaces in the front ends. The two marine-boilers, which are equal in power to the three Cornish boilers, are capable of supplying steam for one pair of engines. The two marine-boilers, or the three Cornish boilers, are worked together as a set, the two sets being used alternately in the same manner as the engines, but for about three months at a time. The chimney is situated between the two sets of boilers. The flue from each separate boiler, enters into a main flue, which extends along the back of each set to the base of the chimney; each is provided with a separate damper, and there is another damper at the end of each main flue, where it joins to the base of the chimney.

On the top of the steam-chest of each boiler is a shut-off valve box, joined by a branch to the main steam-pipe, which leads to the engines. By these valves, any boiler may be shut off from the rest, in case it is required to be cleaned whilst the others are at work. At the mid-length of the steam-pipe are two safety-valve boxes, each having an aperture of 12 inches diameter; they communicate with each other, and from one of them a discharge-pipe proceeds into the chimney; one of these safety-valves is out of the control of the men, but the other may be lifted by means of a lever worked from below, in order to discharge the steam at the end of the day's work.

The feeding of the boilers is effected from a tank situated above the arches, at the side of the chimney, at such a height as to give the column of water entering the boiler a greater pressure than that of the steam. This feeding-tank is 10 feet in diameter, by 6 feet high, and is capable of holding 471 cubic feet of water. The water is raised into this tank by the pumps of the engines, and feed-pipes proceed from the tank to the feed-cocks in the pipes, at the front of the several boilers. During the time the engines are at work, no water is admitted to the boilers, but as soon as they are stopped, the feed-cocks are opened, and the water is allowed to flow in until the proper level is restored. At the same time a fresh supply of coals is thrown on the fires, to raise the steam for starting. This is so managed as to waste very little steam by blowing away at the safety-valve.

The *chimney* is 6 feet square inside, at the base, and 4 ft. 3 in. diameter at the top, and 164 feet high from the foundation. The draught is exceedingly good. The spaces opposite to the row of furnaces of the five boilers are stores for coal. Beneath the centre of the passage, in front of the row of furnaces, is the drain for carrying off the waste water.

The *steam-engines* of 112 horse-power (nominal power) are on the marine construction, with side levers, the same as Messrs. Maudslay, Sons, and Field made for steam-vessels a few years ago. That construction was adopted, as it was requisite that the centre of the shaft should be elevated. The diameter of the cylinders is 56 inches; the length of stroke is 5 feet; and the average number of strokes 22 per minute. The motion of the piston is therefore 220 feet per minute. The plunger feed-pump is 6½ inches diameter, and 2 ft. 6 in. stroke; only one pump is worked at a time. The cranks are all of cast-iron, with axes of wrought-iron, 12 inches diameter in the bearings.

The *large spur-wheel* on the main axis is 17 feet in diameter at the pitch line, with 120 teeth; the pitch of the teeth is 5¼ inches, and their breadth is 23 inches. The centre boss of this wheel consists of two circular pieces bolted together externally, including between them, and closing over the roots of the arms, which are eight in number, cast separately, and bolted to one another, and to the boss. The rim is in eight segments, each having 15 teeth, and the junctions of the segments are made at the ends of the arms. The weight of the wheel is 16½ tons; that of the rim by itself being 8 tons 13 cwt. The *drum* is 23 feet in diameter outside, and 16½ feet in diameter at the bottom of the V-shaped groove, wherein the rope is coiled. The width of this part, at the bottom, is 1 ft. 6 in., and at the top 3 ft. 2 in.; when all the rope is wound on it, the diameter of the outside coil of the rope is 20 feet.

The *break-wheel* at the side of the drum is 14 feet in diameter, and 1 foot broad.

The *mortice spur-wheel*, on the axis of the drum, and at the same side as the break, is 11 feet in diameter at the pitch line: it has 78 cogs, which are also 23 inches broad.

Although the drum, the break-wheel, and the mortice-wheel, have hitherto been mentioned as separate, they are in fact all framed together so as to form one combination. The total weight

is 30 tons. The axis of the drum is of wrought-iron, 12 inches diameter in the bearings. The cogs of the mortice-wheel are made of hornbeam.

The break is formed of two straps of wrought-iron, side by side, each 5 inches wide, to which are rivetted plates of copper in lengths of 3 feet each, 12 inches wide and $\frac{3}{4}$ inch thick; the copper applies to the lower half of the circumference of the break-wheel. One of the extremities of the break is suspended by rods from the girder above, and the other end is connected to the hoop around an eccentric-wheel, the axis of which is mounted in a frame fixed to the girder. On the axis of this eccentric-wheel is a spur-wheel, into which a pinion works, and on the axis of the pinion is a ratchet-wheel, to be worked by a lever-handle and click, by a man standing on the platform over the engine-room, the handle end of the lever passing up through the platform. The length of this lever-handle is 6 feet; the diameter of the pinion is $11\frac{1}{2}$ inches, and that of the wheel is 16 inches; the eccentricity of the eccentric-wheel is $2\frac{3}{4}$ inches. Hence the force of the man's arm applied at the upper end of the lever-handle is multiplied about 36 times $\left(\frac{72 \times 11}{2{\cdot}75 \times 11{\cdot}5} = 36{\cdot}4,\right)$ when the leverage is the least—namely, when the eccentric-wheel has made a quarter of a revolution; but for obtaining a greater power on the break, a piston is fitted into an air-cylinder 10 inches in diameter, which is fixed under the girder; one end of the cylinder is open to the atmosphere, and the other is closed, but communicates by a pipe with the condenser of the steam-engine below. In this pipe is a cock, which can be opened by the breaksman when necessary; a chain connected to the rod of the piston of the air-cylinder, is carried round the spur-wheel and fastened to it. If the breaksman opens the cock to establish a communication with the condenser, the air is exhausted from the air-cylinder, and the pressure of the atmosphere on the area of the piston acts by the chain on the circumference of the wheel. Supposing the vacuum to be 27 inches of mercury, this pressure is 1,060lb., equivalent to about 100lb. applied to the upper end of the lever-handle.

Each of the moving *plummer-blocks*, in which the drum-shaft revolves, is mounted on six rollers; three on each side. Beneath the plummer-blocks and attached to it, in the space between the rollers, is a long nut in which a screw 3 inches in diameter works; the pitch of this screw is such as to move the nut and the plummer-block 3 inches by seven revolutions. The axis of the screw is prolonged by a shaft to reach the platform, and this prolongation has on its end a bevil-wheel 2 feet in diameter, into which works a bevil-pinion 6 inches in diameter; the cross axis of this pinion extends across the breadth of the drum, parallel to its axis, and carries another such bevil-pinion of 6 inches diameter, which acts in another bevil-wheel of 2 feet diameter, on the prolongation of the axis of another screw beneath the plummer-block, for the other end of the axis of the drum. By this connection both screws are turned round simultaneously and act on both plummer-blocks alike. On the cross axes of the two bevil pinions is a cog-wheel 2 feet in diameter, into which works a pinion 16 inches diameter, on the axis of which is a winch-handle, so that to produce one revolution of the screw, the winch-handle must make six revolutions. The thread of the screw making seven turns in 3 inches, and the winch being 10 inches long, the pressure applied to it is multiplied 868 times. The winch is worked by one man, and the time occupied in disconnecting one drum and connecting the other, is little more than a minute.

The rollers on which each plummer-block moves, are made of wrought-iron, case hardened, $3\frac{1}{4}$ inches in diameter, and $2\frac{1}{2}$ inches broad. At first, the rollers worked against the cast-iron surfaces of the frame and of the plummer-block; but after having been at work two or three years, the pressure had caused so much indentation into the two surfaces of cast-iron, as to render it difficult for a man to connect and disconnect the large spur-wheels. To remedy this defect, a strap of steel was let into the frame and another into the underside of the plummer-block for the rollers to act against, and no inconvenience has been since found. The weight upon each of the rollers is about 5 tons. The weight of the drum, break-wheel, and mortice-wheel being 30 tons, and of the axes 3 tons 7 cwt., the rope remaining on the drum when unwound 1 ton, and the additional weight of rope when the whole is wound on, 23·10 tons, makes a total weight of 57·17, or 58 tons, to be sustained on the twelve rollers beneath the two plummer-blocks; and, therefore, supposing each set to bear the same weight, each roller has to carry nearly 5 tons; each end of the axis of the drum being 12 inches diameter in its bearing, the breaks must sustain 29 or 30 tons.

Power.—When all the train is in motion, the engines making 22 strokes per minute, the pressure of the steam on entering the cylinder being $2\frac{1}{2}$ lb. above that of the atmosphere, and the mean pressure 9·95 lb. per square inch, the power for the engines, rope, and train, is 323·74 horse-power.

When the rope, without any carriages attached to it, is drawn by the engines making 24 revolutions per minute, the pressure of the steam being 6 lb. above the atmosphere, and the mean pressure 7 lb. per square inch, the power expended on the rope and machinery is 250·76 horse-power.

When the drum is disconnected from the engines, and they are allowed to make 22 strokes, the pressure being $13\frac{1}{2}$ lb. above the atmosphere, and the mean pressure 8lb. per square inch, the power expended on the friction of the engines unloaded, is 26·09 horse-power.

Since the power expended on the engines, rope, and train, is 323·74 horse-power, and on the engines and rope, 250·76 horse-power; the difference, namely, 72·98 or 73 horse-power is due to the train alone.

The number of revolutions made by the engine-shaft per minute being 22, the number made by the drum in the same time is 33·84. The circumference of the drum when the rope is off, is 52 feet; when all the rope is wound on, it is 63 feet, the velocity of the rope will therefore vary from 1,760 feet per minute, to 2,132 feet, that is, from 20 miles to 24 miles per hour.

The Rope.—When the railway was first opened, the rope employed was of hemp, $5\frac{3}{4}$ inches in circumference, or $1\frac{3}{4}$ inches in diameter. After it had been in use for a very short time it broke, and continued to do so frequently; in consequence of which, a wire rope was substituted. This rope $3\frac{5}{8}$ inches in circumference, or $1\frac{1}{4}$ inch diameter, is formed of six strands, each composed of six wires, or thirty-six wires in the rope. It is covered over with small hempen rope or tarred yarn. The breakages of this rope are much less frequent than with the hempen rope, but still they do occur occasionally. In order to make the rope wind evenly on the drum, it is guided by two levers mounted on one centre pin, and crossing one another in the form of a pair of scissors, the levers having rollers on their inner side. These levers are worked by a man, standing on the platform below, and he guides the rope by pressing them alternately against either side as his eye directs, so as to wind the rope evenly around the drum. The weight of the hempen rope was 8 lb. per yard, that of the wire rope is $6\frac{1}{2}$ lb. per yard; therefore, the weight of the rope lying on the railway was, in the former case, $19\frac{1}{2}$ tons, and in the latter, $16\frac{1}{2}$ tons. Swivels are introduced at intervals in the length of the rope, to allow it to twist and untwist itself in working. The weight of the rope is sustained by bearing-sheaves, disposed at intervals along the line, in the middle of the space between the rails; some of them being laid at angles to suit the curves of the road.

The auxiliary engine.—The cylinder of the 12 horse-power engine is 20 inches in diameter, the piston makes a stroke of 3 feet, and 34 strokes per minute. The two air-pumps which are worked by it are 13 inches in diameter, with a stroke of $10\frac{1}{2}$ inches, and are placed one on each side of the centre of the main lever.

The *air-pumps* of the large engine are 31 inches in diameter, with a length of stroke of 2 ft. 6 in.; so that the capacity of the stroke of each pump is 13·1 cubic feet, or 26·2 cubic feet for the pumps of a pair of engines; therefore, the capacity per minute, is $26{\cdot}2 \times 22$ strokes $= 576{\cdot}4$ cubic feet. In like manner, the capacity of the small pumps, per minute, is 55 cubic feet, or nearly $\frac{1}{10}$th that of the large pumps in the same time.

The well from which cold water is obtained is 10 feet diameter inside, and is steined partly with brick and partly with iron. In this well are two sets of three-barrelled pumps, but only one set is worked at a time. The barrels are each 7 inches in diameter, the stroke is 18 inches, and they make twenty strokes per minute; so that the quantity of water raised by one set, per minute, is 150 gallons. These pumps are worked constantly throughout the day.

The marine-boilers are 10 ft. 3 in. wide, 10 ft. 8 in. high, and 24 feet long; the steam-chests are 5 feet in diameter and 4 ft. 10 in. high; each boiler has three fires within it.

The circular boilers are each 7 ft. 6 in. in diameter, by 24 feet long; the two circular flues, through their whole length are 2 ft. 6 in. diameter. The steam chests are 3 ft. 9 in. diameter, and 4 feet, 5 feet, and 6 feet high respectively. The average consumption of fuel, is, per day, for the two marine-boilers together, $7\frac{1}{2}$ tons, and for the three circular-boilers together, 8 tons. In these quantities is included what is required for getting up the steam in the morning.